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Service and Regulatory Announcements, April-June 1947.—*S.R.A., B.E.P.Q.* no. 168 pp. 21–56. [Washington, D.C.] U.S. Dep. Agric., 1947.

This part includes the text of Quarantine No. 74, designed to prevent the entry into the continental United States, Hawaii and Porto Rico of injurious insects and plant diseases with cut flowers imported from foreign countries [*R.A.E.*, A **36** 71], with Administrative Instructions (B.E.P.Q. 563), effective 1st August 1947, designating flowers of five genera as involving a special risk. A press notice, dated 16th May 1947, gives information on a new method of treating graded potatoes transported in sacks in van-type refrigerator cars or tight-bodied trucks from the area quarantined [under Quarantine No. 48] against the Japanese beetle [*Popillia japonica*, Newm.] in the United States. It involves the application of DDT dust under supervision with a special approved device before and after loading; tests in 1946 showed that most beetles die in transit, and the remainder shortly after the vehicle arrives at its destination. The hatches of refrigerator cars containing potatoes treated in this manner need not be screened while passing though the generally infested area. Analyses of the residues of DDT on potatoes removed from the cars during the experiments showed that the largest was 0·04 part per million, which is considerably below the tentative tolerance (7 p.p.m.) for residues on apples and pears [**35** 110].

Other information includes revised digests of plant-quarantine import restrictions in Bermuda, British Honduras and Persia, and supplements to restrictions already noticed in the Union of South Africa [**26** 691] and Great Britain [**28** 611].

Folsom (D.) & Stevenson (F. J.). **Resistance of Potato Seedling Varieties to the natural Spread of Leaf Roll.**—*Amer. Potato J.* **23** no. 7 pp. 247–264, 31 refs. Washington, D.C., 1946.

The results are given of tests during 1937–44, in which potato seedlings derived from different crosses were exposed to field spread of leaf-roll [*Corium solani* of Holmes] from adjacent rows in an area in south-western Maine where this disease spreads consistently year after year. The parents used at first included commercial American and European varieties reputed to be resistant to leaf-roll, and a few of the hybrids contained some seedlings resistant to natural spread. When these resistant seedlings were used as parents, the resulting hybrids generally were more resistant to field spread than hybrids of other kinds. In the autumn of 1943, some of the seedlings were included in tests in New Brunswick of the resistance to Aphids of various commercial varieties of potato. It was found that many seedlings that were relatively resistant to leaf-roll were susceptible to Aphid injury, whereas others that were susceptible to the disease were not, indicating that resistance to leaf-roll results more from resistance to the virus than from resistance to the vector. It appears possible to combine resistance to leaf-roll with many characters considered commercially desirable in the United States.

Moutia (A.). **Entomological Division.**—*Rep. Dep. Agric. Mauritius 1945* pp. 17–21. Port Louis, 1946.

The usual survey for larvae of *Clemora smithi*, Arr., in sugar-cane fields in Mauritius [*cf. R.A.E.*, A **35** 1] was carried out on 45 estates during 1945, and infestation was found to have decreased on 15 and increased slightly on 11 and considerably on four; on one of the latter, the mean and maximum populations were 266,000 and 417,000 larvae per acre. Infestation was heavy on three estates which had not been included in the survey for some time. Scoliid parasites, chiefly species of *Campsomeris*, were fairly abundant in 11 localities;

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Campsomeris lachesis, Sauss., *C. phalerata*, Sauss., and *C. erythrogaster*, Dalm., which were the principal species in one of them, disappeared completely after three cyclones that occurred in January, February and April, but reappeared in August. *C. pilosella*, Sauss., was not numerous, but adults of *Tiphia parallela*, Smith, which had been scarce in recent years, were seen in numbers in seven localities after the first two cyclones, searching for the plants on which they feed and which were scarce and had been defoliated. *T. parallela* was also reported from two places at the end of the year, at one of which it was numerous. Parasites were collected and distributed at nine places; they comprised 690 of *C. phalerata*, 625 of *C. lachesis*, 380 of *C. erythrogaster*, and 115 of *T. parallela*. Cuttings and plants of *Eupatorium pallescens*, a Javan shrub that is an excellent food-plant for adult Scoliids, were distributed to three estates and planted at Réduit. No Tachinid parasites were obtained from adults of *Clemora smithi* collected at two localities and reared for the purpose.

The sugar-cane moth-borers, *Proceras sacchariphagus*, Bojer, and *Sesamia vuteria*, Stoll, were more injurious than usual owing to scarcity of their parasites. Laboratory studies showed that the life-cycles of *Xanthopimpla stemmator*, Thnb., and *X. citrina*, Hlmgr. [which parasitise *Proceras*] occupy 31 days and 24 days, respectively, in winter and 24 and 16 days in summer. Other pests that became injurious, presumably because the cyclones in the early part of the year destroyed many insectivorous birds and insect parasites and predators, included *Pelopidas borbonica*, Boisd., and *Crambus malacellus*, Dup., on rice, *Aiolopus* sp. on graminaceous plants, *Gryllotalpa africana*, P. de B., on various seedlings and on sugar-cane cuttings, *Pericyma glaucinans*, Gn., on *Poinciana* (*Delonix*) *regia*, which it completely defoliated, and *Trichoptilus wahlbergi*, Zell., on sweet potato. An increase of *Aspidiotus destructor*, Sign., on coconut was associated with the scarcity of Coccinellids, and numerous attacks on *Citrus* by *Papilio demodocus*, Esp., followed a decrease in numbers of the egg parasite, *Telenomus* sp. Various cutworms, notably *Spodoptera cilium*, Boisd., occurred on lawns; they were attacked by a bacterial disease, but attempts to inoculate healthy larvae with three strains of bacteria from them were unsuccessful.

In experiments with locally available inert dusts against pests of stored products, micronised basalt was of value in protecting maize from *Calandra oryzae*, L., but not from *Sitotroga cerealella*, Ol., or *Corcyra cephalonica*, Staint., and trachyte was almost as effective. The yield of beans treated with sprays containing 0·25 and 0·5 per cent. DDT against *Agromyza* (*Melanagromyza*) *phaseoli*, Coq., was increased five times in one series of tests, but did not differ significantly from the controls in another. In an experiment in which recently harvested pulses known to have been infested by Bruchids in the field were stored for two months in sealed petrol tins, the percentages of bored and (in brackets) viable seeds were 2·5 (72·6) for the controls, 0·8 (69·9) for seeds mixed with 5 per cent. talc containing 3 per cent. DDT, and 0·4 (68·5) for seeds stored in tins previously sprayed with 5 per cent. DDT in kerosene.

Richards (O. W.) & Waloff (N.). **The Study of a Population of *Ephestia elutella* Hübner (Lep., Phycitidae) living on Bulk Grain.**—*Trans. R. ent. Soc. Lond.* **97** pt. 11 pp. 253–298, 11 figs., 20 refs. London, 1946.

Ephestia elutella, Hb., became a serious pest of wheat stored in bulk in a London warehouse in the autumn of 1941, and in 1943–45 investigations were carried out in a room with a floor space of 5,000 sq. ft. containing about 500 tons of Manitoba wheat to devise methods of estimating the numbers of each stage present at different times of year. In this paper the methods developed are described and explained and the accuracy of the results obtained is discussed.

E. elutella was never found in Canadian wheat when it entered the warehouse, but the latter contained a permanent population that overwintered there. About 90 per cent. of the overwintering larvae spun their cocoons between the ceiling boards and the remainder in cracks in pillars, pipes and walls ; very few spun winter cocoons in the grain. Pupation began at the beginning of May and reached a peak a month later. The pupal stage lasted 3–4 weeks, depending on temperature, and the moths began to appear at the end of May ; the adult population reached a maximum in the first fortnight of July, after which the numbers fell rapidly, though a few adults were present until the beginning of September. After this there was a very small overlapping population of moths from early larvae that had pupated during their first season. It appeared that the period of peak emergence in the London area was relatively fixed and that exceptional climatic variation was required to alter it by more than a few days. The adults lived for 2–3 weeks and paired soon after emergence and usually several times later. Nearly all the eggs were apparently deposited on the surface of the grain, and the larvae hatched and began feeding on the wheat embryos in 10–14 days at normal summer temperatures [*cf.* next abstract]. The mature larvae appeared above the grain about 20th August and were most numerous between 3rd and 20th September. A few of the earliest pupated at once, but the vast majority spent the winter in diapause in the last instar. Few larvae were visible by the beginning of November. The earliest eggs of the second generation hatched, and the larvae grew slowly during the autumn and winter, if the weather was not very severe, and pupated rather later than the overwintering larvae. Later eggs were sterile.

The number of living moths in the room was estimated each week from counts on regular sample areas, and the number of newly emerged moths each week was calculated from this number and from the average length of life of males and females and the proportion of these present in samples. The methods used to find the length of life are described in the first appendix. The accumulated total of moths was obtained by adding the calculated numbers of newly emerged moths, and this agreed moderately well with estimates of the total moth emergence, determined from the numbers caught in muslin bags covering sample strips of ceiling crevices, and of the total number of dead moths, calculated from the numbers collected on sample areas of wheat, in 1944, when the windows were kept shut. In 1943, when the windows were open, many moths flew out of the room.

In 1943, the numbers of eggs per square foot deposited on the grain were calculated from the average number laid by females isolated in tubes in lighter and darker parts of the room throughout the season and the ratio of light to dark areas. In 1944, the fecundity was determined more indirectly by methods described in the third appendix. A separate estimate of the number of eggs per square foot was obtained by exposing trays of grain for a week in various positions on the surface of the wheat and then incubating the grain at 25°C. [77°F.] for 21–28 days, after which the larvae were large enough to be counted. This was done for eight successive weeks in 1943 and for two in 1944, and the estimates obtained by the two methods of the total number of eggs per week were compared.

No attempt was made to find the number of feeding larvae, but the development of the population was shown by counts of eggs and each larval instar in samples of grain taken weekly from the end of June to the end of September. The average length of the wandering period of full-grown larvae, determined from a graph relating percentage recovery of marked larvae to the number of days after their release, and the weekly estimate of numbers of larvae visible were used to calculate the accumulated total of larvae. This was also estimated from the amount of damage to the grain. Damaged grains were sorted from whole ones in samples of wheat taken mainly from depths of 0–100 cm.

at 30 places in the room, and those apparently injured by *Ptinus tectus*, Boield., eliminated. The average percentage damage was calculated from a graph on which percentage damage was plotted against grain depth, and the total number of damaged embryos from this and the number of grains in the bulk. The average number of embryos devoured per larva was found to be approximately 48, and this was used to give the total number of larvae. The principal cause of larval mortality was a bacterial disease, referred to as wilt, which is probably caused by a non-spore-forming bacillus. The mortality of wandering larvae and those in cocoons in crevices was determined in 1943 and 1944, and that of feeding larvae in 1944. Samples taken mainly at depths of 0–100 cm. showed an average of 10·4 dead larvae per lb. in the top 50 cm., and none below, and from this the total number of dead larvae in the grain was determined. No larvae in the first two instars were found, presumably because they were too small. The mortality of larvae that had left the grain was investigated by putting rolls of corrugated paper on the wheat and in artificial crevices in the ceiling and finding the proportion of dead and living larvae in them. Counts were also made of dead larvae on the surface of the grain and on walls, pillars and ceilings and of the living hibernating larvae in sample crevices, and the ratio of the last to the number of moths produced was calculated.

Insect parasites of the larvae were very rare. A few examples of *Nemeritis canescens*, Grav., and *Angitia chrysosticta*, Gmel., were observed, and in 1944, *Bracon* (*Microbracon*) *hebetor*, Say, was bred from larvae in corrugated paper rolls, but the total percentage parasitism was certainly very low. In the autumn of 1944, spiders (*Tegenaria domestica*, L.) became common in the room and apparently caught an average of one adult of *E. elutella* each per week, the captured moths being chiefly males. At the end of October 1944, the mite, *Typhlodromus tineivorus*, Oudm., which eats the eggs and sometimes cripples the wings of the adults, was noticed hanging on moths, and the numbers of males and females of *E. elutella* examined, the numbers bearing mites and the number of mites per infested moth and of moths with crippled wings are tabulated. The figures show that the mite would have an important effect, if a similar percentage of the moths were infested earlier in the year. Mice and rats occurred in the room ; the former are known to eat *Ephestia* larvae and pupae, but it is not known whether they exerted any control in the granary.

It was found that the changing age-distribution of the adult population could be detected by dissecting samples of females and noting the percentage in which the fat-body was exhausted and the average number of spermatophores. In 1943, counts of spermatophores and of females that had mated once or not at all showed that all moths present after 7th September had developed from eggs deposited the same year. Their numbers were about 1·5 per cent. of those of the main generation, and it appeared unlikely that their progeny would materially increase the next year's population. Observations on the larvae showed that nearly all enter diapause, the few that give rise to adults the same year developing from eggs laid soon after emergence by the earliest moths. Such moths may belong to a genetic stock, part of the offspring of which form the second generation in each year, but the effects of crowding or nutritional factors may also be involved. Larvae collected in the warehouse do not easily end their diapause by pupation in the autumn or early winter, even at 25°C., whereas those collected in January or later all pupate in 2–3 weeks when kept at 25°C., possibly because they have experienced low temperatures. The earlier wandering larvae tend to be heavier than the later ones, and heavier larvae are more likely to survive to pupation irrespective of the date of wandering. There was a longer interval before pupation in heavy larvae than in lighter ones, both at outdoor temperatures and at 25°C., but at the former the light larvae, though having a shorter diapause, produced moths later in the

following year because they wandered later than the heavy ones, the range in the date of wandering being greater than the range in length of diapause. Laboratory experiments showed that in crowded cultures the mortality of larvae is increased and their weight reduced. Apparently similar effects on weight were observed under warehouse conditions, but close comparison could not be drawn between culture jars in which first-instar larvae were introduced on one day and a large bulk of wheat to the surface of which eggs were added over a period of two months.

There was some evidence that the population had passed the optimum density for the species. In 1944, the moths were smaller than in 1943, and the size of the wandering larvae in 1944 suggested that the moths would be still smaller in 1945. The reduction in size was accompanied by reductions in duration of life (22 days in 1943 and 12·5 in 1944) and fecundity (124 eggs in 1943 and 91 in 1944), but it is not yet certain whether this will continue sufficiently to stop the population from increasing. The steady increase in *Ephestia* population in the room studied was in marked contrast to the stable or falling populations in other rooms in which control measures were applied and showed that even imperfect methods were more effective than might be supposed. During the two years of study, there appeared to be an irregular but progressive increase in the proportion of male to female moths, possibly due to differential mortality in the larval stage.

Additional methods of calculation, with the results obtained and discussions of their accuracy, are included in appendices. The first deals with the length of life of the adults, the second with the accumulated total of moths in 1943 and the average weekly number in 1944, and the third with the fecundity of the moths in 1944, when too few insects were studied to establish this directly, with notes on the percentage of total fecundity to be expected in moths of various ages, infertility of the eggs and larval mortality. A few observations made in 1945, which indicated that the effect of overcrowding in 1944 had been very important, about 300,000 moths apparently being the maximum population that could be supported in the room, that the moths continued to decline in weight and that the ratio of males to females was 1 : 1·2, are included in a fourth appendix.

WALOFF (N.) & RICHARDS (O. W.). **Observations on the Behaviour of *Ephestia elutella* Hübner (Lep., Phycitidae) breeding on Bulk Grain.**—*Trans. R. ent. Soc. Lond.* **97** pt. 12 pp. 299–335, 5 figs., 24 refs. London, 1946.

The results are given of warehouse observations and laboratory experiments on the behaviour of *Ephestia elutella*, Hb., made in the course of investigations on an infestation in bulk wheat in London [see preceding abstract]. It was found that females begin to oviposit 24 hours after mating and lay most of their eggs in the first four days of adult life. Since both larvae and young adults are negatively phototactic and the activity of the females is restricted, moths are most numerous in the darkest parts of the store room and most eggs are laid there. Air currents by windows are avoided by the moths, including ovipositing females. Oviposition apparently takes place in the evening and at night, and the eggs are deposited on grain in the absence of other foods, though cacao was more attractive than grain to ovipositing females, irrespective of which product they had been reared on. As the moths grow older they tend to move towards the light. Diffused daylight usually immobilises the moths, and they tend to be quiescent at uniform light intensities above one foot-candle ; at lower intensities there is slight movement throughout the day. There is considerable flight at sunset and sunrise, when the intensity of light is changing, in areas in which the light intensity is less than one foot-candle, and

it was also observed during the day in hot rooms and in conditions of overcrowding. Temperature differences of 3°C. [5·4°F.] are effective in producing aggregates of moths in the warmer parts of the room, the reaction to temperature overriding the effect of light of very low intensity. The thermal receptors are apparently located in the antennae. Preliminary experiments indicate that sharp temperature changes (within 15–30°C. [59–86°F.]) induce movements and that slow changes may have no effect, at least at high light intensities at which the moths are inactive. At temperatures below 25°C. [77°F.] adaptation to thermal changes is rapid.

The larvae feed in the embryos, chiefly in the top 30 cm. of grain, though they sometimes reach depths of 100 cm. or more. They occur mainly in the top 20 cm. of grain in the first and second instars, though they have been found at a depth of 50 cm., and gradually move downwards until the last instar, when they move up and finally leave the grain. Their distribution in the grain is attributed to the fact that each eats about 48 grain embryos to complete its development and that feeding larvae tend to move downwards in confined spaces. This downward movement is not directly proportional to the initial number at the surface, and it is thought that mutual stimulation in crowded conditions leads to greater activity, which is expressed in movement downwards. It is considered that under normal conditions of storage of bulk grain the effect of the water content of the wheat is less important than other factors on larval distribution. The full-grown larvae leave the grain and wander on the walls and ceiling for an average of 1–3 days, leaving a silk trail. They do not follow their own or other trails. They tend to move upwards and away from light. Most of them spin cocoons in crevices of suitable width for pupation or diapause, the choice of crevices being determined by the depth of the head with its setae.

DUFFY (E. A. J.). **A Contribution towards the Biology of *Prionus coriarius* L. (Coleoptera, Cerambycidae).**—*Trans. R. ent. Soc. Lond.* **97** pt. 17 pp. 419–442, 2 pls., 17 figs., 28 refs. London, 1946.

Prionus coriarius, L., occurs throughout southern England and in some localities in the midlands but has not been recorded in Britain further north than Lancashire. It is not considered a serious pest of timber, owing to its small numbers, its preference for ovipositing in mature living but usually damaged trees or stumps and the fact that trees planted for commercial use are felled before they reach maturity, and no control measures are taken against it. However, the larvae cause considerable damage to the roots of living deciduous and coniferous trees, and this is of importance in ornamental plantations, parklands and mature woodlands.

The author gives descriptions of all stages, with a key distinguishing Prionid larvae from those of the other families of Longicorns, and an account of its bionomics, based on observations in southern England and records in the literature. The eggs are deposited deep in bark crevices in batches of 8–12. They hatched in 30–37 days in the laboratory at an average temperature of 60°F. The larvae burrow into the bark immediately after hatching, feed subcortically until the third or fourth instar and then bore deeper, towards the underground roots. They are voracious feeders and can break down four or five times their own bulk of wood within a week; they prefer damaged or rotting roots, and when their supply of food is exhausted may travel through the soil to neighbouring roots. The larvae are susceptible to bruising but proved highly resistant to immersion in water and to frost. During the last instar, they leave the roots and move to within 1–3 inches of the surface of the soil, where they were found to have pupated in earthen cocoons against roots or beside the bole. The literature contains reports of pupation in tree roots

and in cocoons made of wooden chips. The larval stage lasts at least three years and apparently includes 14 instars, though the number may vary. The adults, particularly the males, fly on warm sultry or wet evenings ; they do not appear to feed on foliage, wood or flower-heads, though they have been attracted to sweet baits and occasionally to light. Mating begins a week or two after emergence, and oviposition occurs at night 2–3 days after mating ; it is usually completed in 2–3 days, and the females die 1–2 weeks later. Adults often do not appear until mid-July, though they have been taken in May, and emergence reaches a maximum in August and may continue until October. Males apparently emerge first and seldom live more than three or four weeks. In winter, adults have been found at the roots of old oaks ; many die in such situations, and there is no evidence that any survive the winter.

P. coriarius has been recorded from most of the larger English deciduous and coniferous trees, but was chiefly found attacking oak, birch and beech in southern England, though larvae were also taken from pine, willow and holly. Trees growing in light sandy soil on the edges of woods, particularly those in rather damp situations, were most prone to attack. Adults of the Ichneumonid, *Xorides albitarsus*, Grav., which has been recorded as parasitising *P. coriarius*, were found exploring an infested stump, and it seems likely that centipedes (*Lithobius*) and larvae of *Melanotus rufipes*, Hbst., and *Rhagium bifasciatum*, F., also attack the larvae. Several species of ants were found on stumps infested by *Prionus*, but they did not appear to enter the occupied portions of the burrows.

Gomeza Ozámiz (J. M.). **El descubrimiento del nuevo insecticida 666.** [The Discovery of the new Insecticide 666.]—*Ion* **5** no. 53 pp. 745–750, 9 refs. Madrid, 1945.

The insecticidal properties of benzene hexachloride (666) were discovered in Spain independently of the work in England [*R.A.E.*, A **33** 256], which did not become known there until after the war, and were recognised in the course of investigations on various chlorine derivatives of benzene related to paradichlorbenzene. Its effectiveness against insects of medical importance soon became evident and was recognised officially by the Ministry of War on 20th October 1945. The first tests on agricultural insects were made in February 1944. The chemical composition and properties of benzene hexachloride, and its four known isomers and their boiling points, are reviewed. Tests have shown that the γ isomer is the most toxic, followed by the δ and α isomers, in that order, while the β isomer is practically inactive. The effect of the compound on flying and crawling insects is described. It is less toxic than DDT to man and warm-blooded animals, and no cases of poisoning in man due to its use have been observed. Its toxicity to insects has been thought to be due to its similarity to inositol [*cf.* **33** 257 ; **36** 175] and it is suggested that its ability to penetrate the integument, as well as that of DDT which has been attributed to the chloroform group of the molecule [*cf.* **35** 203], may be due to the benzene radical. The results of tests on various Arthropods of medical or veterinary importance are reviewed elsewhere [B **36** 120].

Entomological Investigations.—*20th Rep. Coun. sci. industr. Res. Aust. 1945–46* pp. 18–24. Canberra, 1946.

Work on the biological control of insect pests and noxious weeds was continued in Australia during the year ending 30th June 1946. *Apanteles glomeratus*, L., appeared to be well established against *Pieris rapae*, L., in the Australian Capital Territory [*cf. R.A.E.*, A **35** 162] and over 1,000 individuals were sent to

South Australia ; a report of its possible establishment near Adelaide was later received. A species of *Pteromalus* closely related to, if not identical with, *P. puparum*, L. [*cf.* **29** 546] was found attacking *Pieris* quite commonly throughout the Capital Territory. Laboratory rearing of *Comperiella bifasciata*, How., and *Metaphycus helvolus*, Comp., which parasitise *Aonidiella aurantii*, Mask., and *Saissetia oleae*, Bern., respectively [**35** 162], was discontinued owing to difficulties in maintaining supplies of hosts ; small numbers of both parasites were recovered from the field near Adelaide, but it seemed unlikely that either would become established. Eighteen consignments of *Bracon* (*Microbracon*) *gelechiae*, Ashm. [*cf.* **35** 162] were received during the year and laboratory breeding was continued ; 10,410 adults were liberated against *Gnorimoschema operculella*, Zell., on potato in New South Wales and the Capital Territory. Eleven further consignments of *Chelonus phthorimaeae*, Gah., were received [*cf.* **35** 162], and improved breeding methods made possible the liberation of 12,706 examples against *G. operculella* in Queensland, New South Wales and South Australia. A further 20 consignments of *Omorgus phthorimaeae*, Cushm. [**32** 170] were received from California, but the numbers that survived the journey were not large enough to enable laboratory stocks to be built up. *Copidosoma koehleri*, Blanch., a South American polyembryonic parasite [**35** 21], was introduced against *G. operculella* in July 1945 and appears to be of outstanding value. This Encyrtid attacks the egg and emerges from the larva of its host, in one of which as many as 20–30 parasites sometimes develop. Seven liberations were made in the Capital Territory during the year, comprising 181,000 examples in a potato-growing area and 1,100 at an experimental farm ; a special cage facilitating mating and affording protection from rain and predators was used, and parasitism among host larvae infesting plants and tubers in the potato-growing area was later as high as 7·5 per cent.

In general, the control of St. John's wort (*Hypericum perforatum*) afforded by *Chrysomela hyperici*, Forst., in the areas in New South Wales and Victoria in which it had been liberated was satisfactory. A colony released in the former State in December 1944 [**35** 161] had already produced a marked effect on the weed, and another liberated in Victoria in November 1944 had made some progress. *C. quadrigemina*, Suffr. (*gemellata*, Rossi) is now considered to be the most effective of the three insects established against the weed in Australia, and the original colony in Victoria [**35** 161] has in three years cleared paddocks that were formerly overgrown by the weed, with little or no regeneration. Some 603,000 adults, partly from this colony, were liberated in three other districts in Victoria. Both this species and *C. hyperici* are established in South Australia, where they were liberated in 1943 and 1944. The main colony of *Agrilus hyperici*, Crtz., in Victoria developed steadily and two in New South Wales made some progress, but have not as yet given any appreciable control. Four consignments, comprising 28,500 examples of *C. quadrigemina*, 10,000 of *C. hyperici*, and about 1,500 of *A. hyperici*, were shipped to California against *Hypericum* ; losses in transit were light, and satisfactory progress by the two species of *Chrysomela* was reported [*cf.* **36** 188].

A moderate, but widespread, outbreak of *Chortoicetes terminifera*, Wlk., occurred in eastern Australia as a result of the breeding and concentration of non-swarming locusts in the outbreak areas. In preliminary observations in eastern New South Wales, swarming locusts were found to prefer the same habitats as non-swarming ones, but showed a gregarious instinct as a result of which females were attracted to spots on which one or two others were already ovipositing. Attempts to control swarm-formation by ecological methods [*cf.* **32** 140] were unsuccessful ; *Atriplex nummularia* was the only species that proved entirely satisfactory in the planting experiments and attempts to produce vegetative cover on scalds, which are important oviposition sites, by sowing species of *Kochia* and *Atriplex* in plough furrows were disappointing.

A. vesicaria was the only species that germinated in appreciable numbers, but it was not abundant enough to be effective unless considerable self-seeding should take place under the protection of the parent plants. An experiment was begun to find whether placing branches of *Apophyllum anomalum* on the bare surface of the scald would facilitate the accumulation of wind-blown sand and the establishment of native grasses and other plants. In laboratory tests of the effectiveness of DDT and benzene hexachloride (hexachlorcyclohexane) (10–13 per cent. γ isomer) against adults and hoppers, dusts containing 5, 10 and 20 per cent. p,p′ DDT or 5 per cent. benzene hexachloride adsorbed on pyrophyllite and ground to pass a 200-mesh sieve were applied to a smooth surface at a rate of 100 mg. per sq. ft.; the insects were confined on the treated surface for 5–125 minutes and then removed to recovery cages and given food. Exposure to benzene hexachloride for only 5 minutes gave an average of 80 per cent. kill, most of the locusts dying within 48 hours; DDT was considerably less effective and rather slower in action.

Experience during the year confirmed the effectiveness of the measures for the control of insect pests in wheat stored in bulk. In Victoria, some 15 million bushels treated with fumigants and mineral dusts [**33** 318] and kept in store for up to three years remained in excellent condition, and in South Australia, about four million bushels of bagged wheat has been successfully fumigated in depots. Experiments have shown that methyl bromide can replace carbon bisulphide for stack fumigation; it gave good results at unfavourable temperatures when used at rates of 1½ and 2 lb. per 1,000 cu. ft. [*cf.* **36** 182]. Laboratory studies on the effectiveness against *Calandra oryzae*, L., and *Rhizopertha dominica*, F., of 70 mineral dusts when mixed with the grain were completed [*cf.* **33** 319]; magnesite was the best of those available locally [**35** 302], and it also formed an effective barrier against crawling adults of the eight most important grain beetles when applied as a band 12 ins. wide. In tests of impregnated dusts, one of crude benzene hexachloride (13 per cent. γ isomer) on pyrophyllite (1 : 1,000) applied to the wheat at rates of 0·5 and 1 per cent. by weight gave complete mortality of *R. dominica* in 6–8 days and of the small strain of *C. oryzae* in 4–6. A similar dust of DDT gave complete control of *C. oryzae* in five days, but only 95 per cent. mortality of *R. dominica* in 14. The pure γ isomer of benzene hexachloride on pyrophyllite (1 : 5,000) gave complete mortality of both species in five days at only 0·5 per cent. by weight. Laboratory tests also showed that the large and small strains of *C. oryzae* do not differ significantly in their susceptibility to highly effective dusts of the type of γ alumina [aluminium oxide], but the large strain is the more susceptible to less effective dusts such as magnesite. In fumigation tests in which the weevils were exposed for three hours at 26°C. [78·8°F.] to ethylene dichloride, a mixture of carbon tetrachloride and ethylene dichloride (1 : 3) and ethyl formate, the small strain was in general the more susceptible, and field and laboratory experience has indicated that it is also the more susceptible to carbon bisulphide.

In work with dusts for the protection of stored potato tubers against *Gnorimoschema operculella*, a high-quality ferric oxide ore ground to pass through a 200-mesh sieve and impregnated with 1 per cent. DDT was the most effective and also imparted a satisfactory colour to the tubers. In field tests at Canberra of dusts and sprays applied to potato haulms during the growing season to control the larvae, three applications of sprays containing Rucide (a preparation containing 50 per cent. p,p′ DDT [**36** 179]), DDT in solvent-naphtha emulsion, and a proprietary DDT emulsion, all diluted to give 0·1 per cent. DDT, afforded the best control, followed by a dust containing 2 per cent. DDT. In experiments in New South Wales, tubers from plants dusted three times at intervals of three weeks during the growing period with 2 per cent. DDT were free from infestation at harvest, whereas infestation in tubers from two lots of untreated plants was 12 and 24 per cent. [*cf.* **35** 276].

Dusts and sprays containing DDT and benzene hexachloride were tested against *Brevicoryne brassicae*, L., and the larvae of *Plutella maculipennis*, Curt., and *Pieris rapae* on cabbage and cauliflower at Canberra. Fortnightly applications of 0·1 per cent. DDT in the form of Rucide or solvent-naphtha emulsion, applied to spring, summer and autumn cabbages at about 100 gals. per acre, gave excellent control of the Lepidoptera, and dusts of 1 per cent. DDT at 30–40 lb. per acre were only slightly inferior. Dusts and sprays of benzene hexachloride were as effective as the DDT treatments at concentrations of 4 and 0·2 per cent., respectively, but not at 2 and 0·1 per cent.; a dust containing 20 per cent. lead arsenate, a spray containing 0·3 per cent. lead arsenate and a dust containing 40 per cent. synthetic cryolite were markedly inferior to both materials. A dust in which 0·5 per cent. DDT was combined with 1 per cent. benzene hexachloride and a spray in which 0·025 per cent. DDT was combined with 0·3 per cent. lead arsenate both showed promise. Predators and parasites kept populations of *B. brassicae* at a low level during the spring and summer, but in the three trials in which infestation was sufficiently heavy to enable reliable conclusions to be drawn, the dusts and sprays of benzene hexachloride gave outstanding control. Combined dusts of nicotine sulphate and DDT gave excellent results against the Aphid and the Lepidopterous larvae when the diluent was pyrophyllite, kaolin, magnesite, calcium carbonate or activated alumina [aluminium oxide], but were ineffective against the larvae when it was hydrated lime, possibly owing to an interaction between the DDT and the lime. The addition of 0·5 or 1 per cent. rotenone from timbo or of Lethane B71 [14 per cent. β-β′-dithiocyanodiethyl ether] to DDT dusts and of nicotine sulphate and soft soap to DDT sprays resulted in good control of the Aphid.

In experiments against orchard pests, a spray programme comprising seven applications of 0·1 per cent. DDT in solvent-naphtha emulsion was as effective against *Cydia pomonella*, L., on apple in the Capital Territory as one of 0·5 per cent. lead arsenate with 1 per cent. white oil, but two emulsions containing 0·1 per cent. benzene hexachloride were of little value. Overwintering eggs of *Tetranychus telarius*, L. (*urticae*, Koch) and *Bryobia practiosa*, Koch, on the fruit spurs of the trees treated with DDT were almost twice as numerous as those on untreated trees, whereas benzene hexachloride and lead arsenate with white oil reduced the numbers to half and one-sixth of the controls, respectively. In an orchard near Canberra, a serious outbreak of mites that developed following the use of a spray containing 0·025 per cent. DDT and 0·4 per cent. lead arsenate was controlled by spraying with 0·75 per cent. white oil, which, however, injured the fruits to some extent, even though applied early in the morning. The mites were also effectively controlled by spraying with Dynone (a preparation of a dicyclohexylamine salt of dinitro-o-cyclohexylphenol) at half the recommended rate and with a mixture of Dynone and 0·1 per cent. DDT in solvent-naphtha emulsion, neither of which injured the trees.

In attempts to develop an improved type of DDT emulsion for horticultural work, in which 63 mixtures, with and without 0·1 per cent. DDT, were tested for their effect on bean and tobacco seedlings, Rucide and emulsified solutions of DDT in toluene, xylene and oil of *Eucalyptus dives* appeared promising [*cf.* **35** 221]; the first two are thought likely to prove the most useful. All the cationic wetting agents tested injured the plants.

In tests on the control of *Iridomyrmex detectus*, F. Sm., at Canberra, a 2 per cent. DDT dust applied at a rate of ⅛ oz. per entrance hole to 111 nests by means of a knapsack duster with a conical adaptor fitted to the discharge tube gave complete control, but did not prevent repopulation by ants from outside the treated area. The dust is relatively cheap as well as more effective and pleasanter to handle than the materials previously recommended [**33** 322]. A dust of 5 per cent. benzene hexachloride applied to the nests at the same rate

gave high initial mortality and prevented the development of troublesome populations during the summer, but was less effective than DDT.

Work on the yellow dwarf disease of tobacco was continued at Canberra [*cf.* **35** 162], where the percentage of diseased plants was reduced by 16 per cent. when *Orosius* (*Thamnotettix*) *argentatus*, Evans, which transmits the virus, was controlled by means of a spray of 0·1 per cent. DDT in solvent-naphtha emulsion ; the average height of treated plants was increased by 10 ins. and there was also a slight increase in the length of the longest leaf as compared with the controls. The results of a similar test in Victoria were inconclusive, owing to the development of a heavy infestation of the Jassid as a result of favourable conditions. Records obtained during the annual survey of abundance of the potato Aphids, *Myzus persicae*, Sulz., and *Macrosiphum solanifolii*, Ashm. (*gei*, auct.) indicated the same trends as in the previous year [**35** 162].

Lyle (C.). **Achievements and Possibilities in Pest Eradication.**—*J. econ. Ent.* **40** no. 1 pp. 1–8, 2 refs. Menasha, Wis., 1947.

The author gives chronological lists of insects and a few other invertebrates that have been eradicated in the United States or elsewhere, with very brief notes on the circumstances. Most of them are pests of crops. He considers that more attention should be given to such work and discusses a few other insects of which the eradication from the United States would be desirable and might be possible.

Jaynes (H. A.) & Marucci (P. E.). **Effect of artificial Control Practices on the Parasites and Predators of the Codling Moth.**—*J. econ. Ent.* **40** no. 1 pp. 9–25, 1 ref. Menasha, Wis., 1947.

Since a high degree of control of *Cydia* (*Carpocapsa*) *pomonella*, L., is not usually obtained in West Virginia even when 4–7 cover sprays are applied to apple trees, investigations were begun in 1936 to determine whether it would be practicable to reduce or eliminate spraying, while continuing all other control measures, in order to encourage the development of natural enemies. In 1938–40, the work was extended to include a study of the relative value of various factors of natural control and the effect of artificial control on them, and to develop methods of sampling for parasite, predator and host populations and of evaluating and comparing natural control in sprayed and unsprayed orchards. The results obtained in 1938–40 are given in this paper and discussed [*cf. R.A.E.*, A **30** 193]. The work was carried out in two apple orchards, one of which was sprayed according to commercial practice, with lead arsenate and nicotine, whereas the other received a petal-fall spray of lead arsenate, but no cover sprays. The commercial orchard had higher percentages of total sound fruit than the other (56–75 and 28–38·3, respectively) in all three years, and more sound harvested fruit (72 and 50 per cent., respectively). The unsprayed orchard had a much larger population of larvae at the beginning of the second generation, but proportionately much less injured fruit while this brood was present.

The following is largely based on the authors' summary and conclusions. The eggs were attacked by *Trichogramma minutum*, Ril., which parasitised up to 28 per cent. of the first-generation eggs, but was usually less effective against those of the second generation, though they were more numerous, and by *Leptothrips mali*, Fitch, which spent the early summer on the cover crop and rarely fed on the first-generation eggs, but migrated to apple foliage as the season progressed and fed on eggs of the second generation. Both *T. minutum* and *L. mali* appeared to be adversely affected by sprays. Parasites afforded little reduction of the larvae. The commonest was *Ascogaster quadridentata*,

Wesm., which attacked only a relatively small number, but was far more numerous in the unsprayed than in the sprayed orchard. Numerous predators attacked mature larvae seeking for places in which to spin their cocoons. Experiments in 1938 showed that 30 per cent. or more of such larvae released near the base of the tree were attacked by predators within 24 hours, and in 1939, 17 per cent. were destroyed in the commercial orchard and 14 per cent. in the other. Ants caused most of this mortality. *Formica fusca* var. *subsericea*, Say, was by far the most destructive, and *F. pallidefulva schaufussi incerta*, Emery, *Aphaenogaster fulva aquia*, Buckley, *Tetramorium caespitum*, L., *Solenopsis molesta*, Say, and *Monomorium minimum*, Buckley, were also important. All these ants, except *T. caespitum*, were more numerous in the untreated orchard.

The fungus, *Beauveria bassiana*, exerted some control of the larvae in all stages. In laboratory tests, it gave high mortality when the spores were either dusted on or inoculated into healthy hibernating larvae or summer larvae that had just spun their cocoons, and a dust or spray of the spores applied to infested fruits prevented newly hatched larvae from entering them and killed larvae that had already entered. Small-scale field tests showed that artificial dissemination of spores on the foliage produced a significant increase in mortality of larvae. The fungus is particularly effective in cool, wet seasons.

The cocoon stage was probably the most vulnerable to attack by predators. Cocoons under bands on the tree trunks were heavily attacked, and many of those on the ground and in trash were destroyed. Ants, particularly *S. molesta*, *M. minimum A. fulva aquia* and *T. caespitum*, destroyed the greatest numbers.

ANDERSON (R. F.). **Saratoga Spittlebug Injury to Pine.**—*J. econ. Ent.* **40** no. 1 pp. 26–33, 3 figs., 4 refs. Menasha, Wis., 1947.

Considerable injury to *Pinus banksiana* and *P. resinosa* involving the death of certain trees has occurred since 1940 in the Lake States. It has been attributed to adults of *Aphrophora saratogensis*, Fitch [*cf. R.A.E.*, A **33** 107] but A. J. Riper isolated several fungi from the margins of injured parts of *P. banksiana* in 1943, the most important being *Chilonectria cucurbitula*. Entomological and mycological investigations were therefore begun in Wisconsin in 1944, and the results of the former are here described.

It was found that the insects fed most heavily on the needle-bearing parts of the branches, and that there was no significant difference in the number of feeding punctures on upper and lower branches. Where *P. banksiana* and *P. resinosa* were growing together, the latter was the more heavily attacked. Studies on *P. banksiana* showed that the Cercopid was extremely voracious and capable of causing a severe drain on the sap of the tree. Individual adults excreted about $\frac{1}{3}$ cc. of liquid every 24 hours and produced a necrotic spot about 3 sq. mm. in area in the inner bark. There was an inverse relation between the number of feeding punctures and the moisture content, ability to conduct water and water consumption of the shoot. It is probable that further injury was caused by the extraction of elaborated food and by interference with food translocation, the death of the needle-bearing twigs being comparable in effect with complete defoliation.

In 1944, transformation from nymph to adult continued for a month from 2nd July, and the adults were most abundant on pine during July and the first half of August [*cf. loc. cit.*]. Comparison of puncture counts made in September with counts of dead branches and twigs in June 1945 showed that the amount of injury varied directly with the insect population. When trees that had been injured to the extent of about 20 ft. of dead branch and twig each in 1943 were kept relatively free from attack in 1944 by spraying with an emulsified solution of technical DDT in xylene (8·3 lb. DDT per 100 U.S. gals.)

during the first week of July, they had suffered little additional injury by June 1945, although the dead parts had been covered with numerous perithecia of *Chilonectria cucurbitula* in the autumn of 1944 and similar untreated trees were injured. Adults that developed from nymphs kept in cages during the last few days before the final moult caused severe injury to healthy branches on which they were caged in 1944, in spite of the fact that they survived for a relatively short time in the cages ; 55 per cent. of the twig mortality occurred during the latter part of the summer and the remainder between October 1944 and mid-June 1945. The injury was more severe on the tops than on the laterals, on none of the branches had the injury continued below the limit of the cage by July 1946, when the last observation was made, and all the injured trees and branches continued growing from the uninfested side branches. Although none of the caged insects had fed on injured pine, perithecia of *Chilonectria* were present on the dead portions of some of the caged branches in the summer of 1945.

It is pointed out that injury always varied directly with the severity of attack by *A. saratogensis* and that the fungus, which was reported to be constantly present when spreading necrosis of the inner bark occurred, appeared to confine its activity to subnormal tissues and particularly those on which insect feeding had been heavy.

Shaw (J. G.). **Hosts and Distribution of *Anastrepha serpentina* in northeastern Mexico.**—*J. econ. Ent.* **40** no. 1 pp. 34–40, 2 figs., 9 refs. Menasha, Wis., 1947.

Since 1933, adults of *Anastrepha serpentina*, Wied. [*cf. R.A.E.*, A **33** 397], which had previously been considered a tropical species, have been commonly trapped in the extensive *Citrus* groves of the lower Rio Grande Valley of Texas but the only records of infestation of *Citrus* fruits by the larvae are one from Texas, one from Trinidad and six from Panama. Since no instance of infestation of other fruits in Texas is known, it is unlikely that the fruit-fly breeds there. This Trypetid also occurs in north-eastern Mexico, and a list is given of 12 fruits found infested by it there in investigations in 1936–42, showing the numbers of larvae found and the months in which infestation occurred ; they include peach and apple, which were only lightly infested, and several tropical sapotaceous fruits that were often heavily attacked, but not *Citrus*. It was suggested by A. C. Baker that *Bumelia laetevirens*, which was lightly infested, might prove the source of the flies in Texas, but this plant, though widely distributed in Mexico, does not apparently grow within 100–125 miles of the lower Rio Grande Valley. Population changes were studied in Texas and in Tampico Alto, Vera Cruz, by means of bait-traps. More adults were captured in June, July and August in tropical fruit trees in Vera Cruz than during other months, and in both Texas and Mexico, adults were in general most commonly trapped during the summer, late autumn and early winter. The prevailing winds are from the south or south-east at Brownsville, Texas, and there may be some northward drift of fruit-flies from Mexico. The adults found in Texas may originate from deciduous fruits or from *B. laetivirens* growing in the semi-arid region of north-eastern Mexico or from tropical fruits growing further south.

Eide (P. M.). **Experiments with Insecticides on Honeybees.**—*J. econ. Ent.* **40** no. 1 pp. 49–54. Menasha, Wis., 1947.

In the laboratory experiments described, the materials were tested for contact action by applying small quantities to cards and inserting them into the cages, in such a manner that honey bees would walk on them but would not have to

ingest them, and for stomach action by mixing them with honey and water and allowing the bees to feed on the mixture through the cage; they were also applied as sprays or dusts to the caged bees. Honey was provided three or four times a day.

The results are shown in a table and discussed. Synthetic cryolite and calcium arsenate were both highly toxic, and DDT was toxic in all cases and gave complete mortality in most. Piperonyl cyclohexanone, a contact insecticide used with a small amount of pyrethrum, was highly repellent in honey, but had little toxic effect, and 2, 4-dinitro-o-cyclohexylphenol as DN-111 [a preparation of the dicyclohexylamine salt] was toxic except as the spray. Rotenone had no effect as a spray or very dilute dust, but killed nearly 50 per cent. of the bees as a 3·5–4 per cent. dust prepared from derris and was fairly toxic as a stomach poison. A 20 per cent. dust of sabadilla was one of the most toxic materials tested, and deposits of it retained their toxic effect for over nine days. Hexaethyl tetraphosphate, a contact insecticide of German origin, was highly toxic as a spray and dust, the dried residue from a spray giving complete mortality 18 hours after application and some mortality nine days after. Xanthone (dibenzyl pyrone) was slightly repellent but not at all toxic to bees, and dimethoxy-trichlorethane, an analogue of DDT, was only slightly toxic when used as a spray or administered in honey, but highly so when bees were allowed to crawl over a treated surface. Chlordane (Velsicol 1068) [*cf. R.A.E.*, A **35** 119; **36** 225–226], at a concentration of 20 per cent., killed no bees, but the sample used was possibly of poor quality, and phenothiazine showed only slight toxicity.

It is concluded that piperonyl cyclohexanone, xanthone, chlordane and phenothiazine are not toxic to bees, rotenone and dimethoxy-trichlorethane are toxic under certain conditions and cryolite, calcium arsenate, dinitro compounds, DDT, sabadilla, hexaethyl tetraphosphate and benzene hexachloride are highly toxic, though DDT is much less toxic than calcium arsenate or cryolite when used as a 5 per cent. dust.

Carlson (E. C.), Breakey (E. P.) & Webster (R. L.). **The Cabbage Maggot in northwest Washington.**—*J. econ. Ent.* **40** no. 1 pp. 57–64, 1 fig., 5 refs. Menasha, Wis., 1947.

Hylemyia brassicae, Bch., is one of the most important insect pests of cabbages grown for seed in western Washington [*cf. R.A.E.*, A **33** 100], where the prevalent cultural practices favour its development by providing a continuous and abundant supply of food-plants. In addition, there is a considerable acreage of cruciferous root crops, which contribute towards building up the population. Daily fly catches in three seasons indicated that there are four or five generations in the year, depending on weather, and that the activity of the flies is reduced by low temperatures and high rainfall. The seedlings are very susceptible to injury, and infestation is carried with them into the open fields. The newly set plants are even more susceptible and need a month or more to take root and develop enough to withstand the effects of attack. The seedlings are transplanted when adults of the fourth and fifth generations are present and may be heavily infested if the temperature is high and rainfall low when they are becoming established.

In tests made in 1943–45 of a number of materials for the control of *H. brassicae* in the plant beds, the results of some of which have already been noticed [**34** 73; **35** 299], a dust of mercurous chloride (calomel) in lime (1 : 24), applied in a thin stream adjacent to the plant stems gave 76 per cent. control in 1944, and a similar dust in gypsum, which flowed more readily, gave 79 per cent. in 1944 and 87·4 per cent. in 1945. In 1944, a suspension of 1 oz. mercurous chloride in 10 U.S. gals. water, with the addition of ½ oz.

powdered bentonite to hold it in suspension, gave 90 per cent. control when applied as a drench along the rows, but only 54·9 per cent. when used as a spray, probably because this method of application did not place enough of the material near the plant stems. In 1945, a suspension of mercurous chloride in water, without bentonite, gave only 76·4 per cent. control. The dusts were applied at 1 lb. per 100 ft. of row (435 lb. per acre) and the suspensions at 1 U.S. gal. per 50 ft. row (871 U.S. gals. per acre). Dusts of 5 per cent. diphenylamine in lime and gypsum gave 91·8 and 84·3 per cent. control, respectively, in 1945, but the former caused severe plant injury and the latter moderate damage.

Most of the other materials were ineffective, but an emulsion of dichlorethyl ether (1 : 236) and dusts and sprays containing low concentrations of DDT showed some promise and these should be tested at higher concentrations.

It is recommended that treatment with a mercurous-chloride dust should be begun as soon as the seedlings appear and repeated at intervals of ten days ; it should also be used on the newly transplanted cabbages.

Pepper (J. H.), Hastings (E.) & Douglas (T. A.). **The Mode of Absorption of Carbon Tetrachloride by Wheat.**—*J. econ. Ent.* **40** no. 1 pp. 64–73, 4 graphs, 6 refs. Menasha, Wis., 1947.

Experiments designed to give data that could be subjected to theoretical treatment to determine the type of reaction taking place between wheat and carbon tetrachloride used for fumigating it were carried out with a uniform sample of cleaned hard winter wheat, the average composition of which is given. Similar tests were made with uncleaned wheat and ground wheat. It is considered that at the temperature and pressures employed, the carbon tetrachloride would be relatively non-reactive chemically. A known quantity of air saturated with carbon tetrachloride was introduced into a reaction flask containing a weighed quantity of wheat, and the amount of carbon tetrachloride taken up by the wheat was calculated from measurements of the reduction in pressure in the flask. Flasks into which only air was introduced showed no pressure changes. The method is described in detail, and the calculations are shown. From analysis of the results, it is concluded that the observed extent of absorption of carbon tetrachloride by whole wheat could be explained by assuming the formation of an ideal solution in the wheat oils, calculations from the absorption data indicating that the effective solvent constituted about 2 per cent. of the weight of the wheat, which is in very good agreement with the reported fat content of the type of wheat used. Samples of ground wheat absorbed additional amounts of carbon tetrachloride that were evidently not held in ideal solution. The heat of absorption, calculated from the temperature coefficients of the absorption by both unground and ground wheat, was found to be close to the heat of condensation of carbon tetrachloride vapour to pure liquid. Virtual absorption equilibrium was attained within one day with ground wheat, but took almost three weeks with unground wheat, and the equilibrium data are used to illustrate the construction of practical graphs showing how much of a suitable fumigant must be introduced under specified conditions in order to establish any desired equilibrium concentration of gaseous fumigant.

Weinman (C. J.) & Decker (G. C.). **Toxicity of some Chlorinated Phenol Derivatives.**—*J. econ. Ent.* **40** no. 1 pp. 74–78, 5 refs. Menasha, Wis., 1947.

The results are given of laboratory tests of the toxicity of pentachlorphenol and 24 derivatives of chlorinated phenols to house-flies [*Musca domestica*, L.], larvae of *Attagenus piceus*, Ol., and various stages of *Tetranychus telarius*, L., and of their effect on plants.

When the compounds were applied against house-flies in solutions in benzene and Deobase oil, none was quite so toxic as pentachlorphenol, which gave complete mortality at 5 per cent. by weight in 24 hours and 74 per cent. mortality at 2·5, and solutions of allyl pentachlorphenyl ether, the second in toxicity, were almost as irritating to man when sprayed into a room as solutions of the free phenol. Many were completely ineffective. When dissolved in benzene, acetone or other suitable solvent, and applied to white woollen cloth by immersion, the propyl, n-butyl and mixed primary amyl ethers of pentachlorphenol were very toxic to *A. piceus*, 0·5–5 per cent. solutions killing the larvae more quickly than similar concentrations of DDT, and the 5 per cent. treatments retained their effectiveness for 9–15 months. Unlike pentachlorphenol and the allyl ether, which were also highly toxic, they did not stain the wool and had no irritating properties. The butyl ether is highly toxic and repellent to clothes moth larvae. Tests of many of the pentachlorphenol ethers as stomach poisons have indicated fair to very high toxicity for the alkyl ethers in the range of C_3–C_5 to most Coleoptera, but moderate to very low toxicity to most Lepidoptera.

Pentachlorphenol was extremely toxic to all stages of *T. telarius* on rose leaves, but injured various plants that were sprayed with it. Several of the other compounds tested had the same properties, but the methyl, propyl, butyl, amyl and tetrahydrofurfuryl ethers, dissolved in acetone and distilled water (65 : 35) with the addition of sodium decylbenzenesulphonate (Santomerse D) at 1 : 3,000 as a wetting agent, gave high mortality at concentrations lower than their threshold of toxicity to plants. The methyl ether had the greatest margin of safety and deposits from it retained their toxicity for several days. It was difficult to incorporate in emulsions, because of its low solubility in all the solvents commonly used in plant sprays, and most of the attempts to apply it in this way resulted in partial crystallisation in the spray tank. The deposition of crystals on the leaves, however, greatly favoured the retention of toxicity. The propyl ether gave 90–100 per cent. mortality of the active mites and was effective against the eggs and resting stages at a concentration of 1 : 500, and the other ethers at 1 : 1,000. When used as a water suspension, the methyl ether at 1·6 lb. per 100 U.S. gals. gave only 80 per cent. kill of mobile mites and practically none of eggs or resting stages.

It was found that the toxicity of the alkyl ethers of pentachlorphenol increased from the methyl to the amyl and decreased from the amyl to the dodecyl compounds. Aryl and aralkyl ethers were practically non-toxic.

Stearns (L. A.), Parker (W. L.), MacCreary (D.) & Connell (W. A.). **A Chlorinated Bicyclic Terpene used to control certain Fruit and Vegetable Insects.**—*J. econ. Ent.* **40** no. 1 pp. 79–83, 4 refs. Menasha, Wis., 1947.

The chlorinated bicyclic terpene designated Toxaphene has the approximate empirical formula $C_{10}H_{10}Cl_8$ and can readily be prepared in oil-soluble, water-dispersible and wettable-powder forms and as a dust concentrate. As a 25 per cent. wettable powder, it was compatible with sulphur, Fermate [ferric dimethyldithiocarbamate], Bordeaux mixture, other copper fungicides, lead and calcium arsenates, summer oils and nicotine sulphate. Pyrax ABB [pyrophyllite] was a satisfactory diluent for the 50 per cent. dust concentrate. The water-dispersible form was not used in combination with other materials, and no plants were treated with the oil-soluble concentrate. The 25 per cent. wettable powder caused no injury on string or lima beans, but severe dwarfing and sometimes death of cucumbers and cantaloupes when used at 1 or 2 lb. per 100 U.S. gals., and it caused no injury to apples, grapes or peaches, but slight temporary yellowing of the terminal leaflets of potato, at 1 lb. per 100 U.S. gals. The 50 per cent. water-dispersible powder at 1 lb. per 100 U.S. gals. caused no

injury to apple, grape or peach but severe chlorosis of potato. As a 2·5 or 5 per cent. dust, Toxaphene caused no injury to string or lima beans but severe injury to cucumbers, cantaloupes and squash. The product appeared to have practically no fungicidal properties.

In tests against the codling moth [*Cydia pomonella*, L.] in Delaware in 1946, apple trees given a petal-fall spray of 3 lb. lead arsenate per 100 U.S. gals. and six cover sprays of Toxaphene or DDT (1 lb. in the first and fourth and ¾ lb. in the others) or of ½ lb. Toxaphene or DDT, with the addition of 3 lb. lead arsenate in the first and fourth and 3 U.S. quarts summer oil (83 per cent.) in all but the first, with fungicides, had 75, 95·5, 85 and 99 per cent. uninjured fruit at harvest, respectively. There was no excessive residue on the fruits, and the population of red mites was less than five per leaf throughout the treated block, though it was consistently greater on trees treated with DDT than on the others. The standard programme of lead arsenate, oil and nicotine gave 93 per cent. uninjured fruit. In tests on peach, applications of 1 lb. Toxaphene or DDT with 7½ lb. magnetic sulphur paste (70 per cent.) per 100 U.S. gals, in the petal-fall and two cover sprays did not reduce the infestation of the fruit by the plum curculio [*Conotrachelus nenuphar*, Hbst.], twig injury by the oriental fruit moth [*Cydia molesta*, Busck] or the activity of parasites of the moth. Two supplementary applications in July of 1 lb. Toxaphene or DDT with 7½ lb. sulphur and 1 U.S. quart summer oil (83 per cent.) per 100 U.S. gals. reduced twig injury by 23 and 44 per cent. and parasitism by 33 and 27 per cent., respectively.

In field tests against the Mexican bean beetle [*Epilachna varivestis*, Muls.], in which applications were begun when young larvae became numerous and repeated at intervals of 5–8 days until hatching was over, dusts of 2·5 per cent. Toxaphene and DDT, 5 per cent. Toxaphene and DDT and 0·75 per cent. rotenone gave yields of 2·9 and 2·9, 2·2 and 2·1, and 1·8 tons per acre when applied to lightly infested string beans at 50 lb. per acre, and of 6·1 and 5·2, 6·3 and 4·8, and 6·1 tons per acre when applied to heavily infested lima beans at 135 lb. per acre. Sprays containing 1 lb. Toxaphene or DDT, 2 lb. Toxaphene or DDT and 0·15 lb. rotenone per 100 U.S. gals, gave yields of 2·6 and 2·3, 2·9 and 1·7, and 2·4 tons per acre when applied to the string beans at 100 U.S. gals. per acre, and of 5·4 and 4·2, 5·6 and 6·3, and 3·9 tons per acre when applied to the lima beans at 160 U.S. gals. per acre. Untreated string and lima beans yielded 2·2 and 2·4 tons per acre, respectively. The DDT treatments caused temporary yellowing and slight stunting of terminal growth. Cucumbers planted on 13th June were sprayed or dusted with Toxaphene, DDT or rotenone three times between 24th June and 26th July and cantaloupes planted on 6th May were dusted six times between 22nd May and 26th July for the control of the striped and spotted cucumber beetles [*Diabrotica melanocephala*, F., and *D. duodecimpunctata*, F.], and all were treated with a fungicide three times in July. Insect populations were not high on either crop, and the yields were not significantly greater on the plots treated with rotenone or DDT than on untreated ones. Toxaphene caused severe injury to both crops, as a result of which yields were negligible. On potato, five applications of ¾ lb. DDT or Toxaphene per 100 U.S. gals. with or without a copper fungicide, reduced the numbers of leafhoppers [*Empoasca fabae*, Harr.] and the defoliation caused by them ; DDT alone resulted in a higher yield and the other treatments in lower yields than no treatment.

Weinman (C. J.) & Decker (G. C.). **An Analysis of certain Factors relating to Control of Grasshoppers with some Chlorinated Hydrocarbon Insecticides.** —*J. econ. Ent.* **40** no. 1 pp. 84–90, 5 graphs, 3 refs. Menasha, Wis., 1947.

The author describes small-plot, greenhouse and laboratory tests in Illinois on the control of grasshoppers with dusts and sprays of technical chlordane, which

is stated to contain 60–75 per cent. chlordane (1,2,4,5,6,7,8,8-octachlor-4,7-methano-3a,4,7,7a-tetrahydroindane) and 25–40 per cent. related compounds toxic to insects, DDT, benzene hexachloride and Toxaphene (chlorinated camphenes [*cf.* preceding abstract]). The results of tests in which grasshoppers (about 90 per cent. nymphs of *Melanoplus femur-rubrum*, Deg.) were sprayed or dusted with benzene hexachloride, chlordane or Toxaphene on plots of lucerne or caged over the treated area 30 minutes after spraying or dusting showed that all three materials act both as stomach and as contact poisons, since in every instance mortality was higher and occurred more quickly when both the insect and the foliage had been treated, though benzene hexachloride appeared to act chiefly by contact and DDT, chlordane and Toxaphene chiefly as stomach poisons. Benzene hexachloride showed a less persistent effect but a much more rapid contact action than chlordane or Toxaphene. When adults of *M. differentialis*, Thos., were caged over potted bean plants 1, 3, 6, 12, 19 and 33 days after the plants had been heavily sprayed with technical DDT, chlordane, Toxaphene or 37 per cent. γ benzene hexachloride, all at 1 : 500 dissolved in acetone and distilled water (65 : 35), with sodium decylbenzene-sulphonate (Santomerse D) at 1 : 3,000 as a wetting agent, benzene hexachloride and DDT had lost almost all their toxicity in 12 and 19 days, whereas Toxaphene and chlordane gave complete mortality for 12 and 19 days, respectively. In a similar test with wettable powders of DDT, chlordane and Toxaphene at 1 lb. toxicant per 100 U.S. gals. and a wettable powder containing 5·75 per cent. γ benzene hexachloride at 3 lb. per 100 U.S. gals., applied at rates similar to those used in the field, DDT was completely ineffective, Toxaphene gave 30–50 per cent. control for the first seven days and none after 11 days, and benzene hexachloride and chlordane gave complete mortality for 1 and 11 days, respectively. In a further test with chlordane emulsions prepared with different solvents and emulsifiers, there were no significant differences in initial toxicity or persistence of residue when sprayed plants were infested with adults of *M. differentialis* at intervals of 1–18 days after treatment, but there was some indication that the water-soluble type of emulsifier produced less persistent residues than an oil-soluble emulsifying agent.

In field tests, crops sprayed with chlordane resisted reinfestation from adjacent, heavily infested areas so completely that a powerful repellent effect was assumed, but cage tests with all four materials gave inconsistent results, though plants sprayed with DDT showed slightly more feeding than untreated ones and those receiving the other three materials rather less. Adults of *M. differentialis* caged with equal numbers of dead poisoned or untreated grasshoppers and no other food ate less than 40 per cent. of them in ten days in most cages, and the rate of mortality was about the same for those with access to poisoned and unpoisoned grasshoppers and those caged without food, indicating that cannibalism cannot be an important source of mortality in the control of this species.

In laboratory tests in which second-, third- and fourth-instar nymphs of *M. femur-rubrum* were kept for various lengths of time in glass cages sprayed with predetermined dosages of 37 per cent. γ benzene hexachloride or with technical DDT, chlordane or Toxaphene, benzene hexachloride showed the greatest toxicity, followed closely by chlordane, and Toxaphene appeared to be the least toxic. In tests of the four materials as contact poisons, in which known quantities in acetone were applied to the metathoracic and first abdominal terga of weighed adults of *M. differentialis*, which were later transferred to screen cages and given food, the highest dosages tested of Toxaphene (0·7496 mg. per gm. body weight) and DDT (1·6347 mg. per gm.) were below the median lethal doses, and benzene hexachloride was effective at lower dosages and acted more quickly than chlordane, the median lethal doses apparently lying between 0·011 and 0·013 mg. per gm. and between 0·0195 and 0·022 mg.

per gm., respectively. In stomach-poison tests, in which the grasshoppers were caged for 18–24 hours with pieces of maize leaf bearing known quantities of toxicant and the quantity consumed was measured, the highest dosage of DDT (0·2592 mg. per gm.) was below the median lethal dose, and the median lethal dose of Toxaphene appeared to lie between 0·086 and 0·105 mg. per gm. The results with benzene hexachloride and chlordane were rather variable, but indicated median lethal doses of about 0·035 and 0·014 mg. per gm., respectively [*cf. R.A.E.*, A **35** 120]. Grasshoppers fed with lethal amounts of benzene hexachloride and chlordane almost always died 1–2 days after the tests were begun and those fed with Toxaphene were dead at the end of the second day ; those fed with amounts of benzene hexachloride within and below the median lethal dose died in less than two days or survived the test, whereas with Toxaphene there was a gradual increase in the survival time to 3·5 days as the amount decreased below the median lethal dose, and a similar effect was observed for chlordane.

Weinman (C. J.), Decker (G. C.) & Bigger (J. H.). **Insecticidal Sprays and Dusts for Control of Grasshoppers.**—*J. econ. Ent.* **40** no. 1 pp. 91–97, 3 refs. Menasha, Wis., 1947.

The results are given of field experiments with DDT, benzene hexachloride and technical chlordane [*cf.* preceding abstract] for the control of *Melanoplus femur-rubrum*, Deg., and *M. differentialis*, Thos., on mixed crops in 16 counties of Illinois. Sprays of 8–20 oz. of two emulsion concentrates of chlordane and an emulsifier (Atlox 1045A) in no. 9 oil (62 : 5 : 33 and 50 : 20 : 30) in 100 U.S. gals. water per acre, applied with a power sprayer to red clover [*Trifolium pratense*] heavily infested with second- and third-instar nymphs of *M. differentialis* on 28th June gave almost complete control for at least ten days, with no difference between treatments. It seems likely that the degree of emulsification and wetting have little effect on the toxicity of chlordane to grasshoppers, and the results obtained by growers who used hand sprayers and other simple equipment indicated that the method of application is also unimportant. When grass and weeds in an orchard with 25–30 nymphs and adults of *M. femur-rubrum* per sq. yd. were dusted with benzene hexachloride diluted to contain 1 and 0·5 per cent. γ isomer at 30 lb. per acre, 1 and 0·5 per cent. chlordane at 20 lb. and 5 per cent. DDT at 40 lb., the numbers of grasshoppers per sq. yd. were 0 and 3, 15 and 20 and 23 after 24 hours and 8 and 10, 5 and 10 and 22 after 96 hours, respectively. There was no appreciable difference between dusts applied when the foliage was dry and when it was wet with dew. Benzene hexachloride reached its maximum effectiveness in 24 hours, reinfestation beginning on the second day after dusting, whereas the grasshoppers continued to die in the plots dusted with chlordane for at least four days after treatment. A comparison of dusts with sprays prepared from emulsive concentrates and wettable powders showed that when benzene hexachloride was applied at approximately 0·3 and 0·15 lb. γ isomer per acre, the dust was more effective than the emulsion and equally effective, respectively, wettable-powder sprays containing about 0·17 and 0·09 lb. γ isomer per acre being less effective. For chlordane, used at 1 and 0·5 lb. toxicant per acre, the emulsion was equal and superior, respectively, to the wettable-powder spray, and the dust the least effective. DDT (1 lb. per acre) had no appreciable effect. It appeared that if dusts are to be used, benzene hexachloride is more effective than chlordane, but that chlordane sprays were as effective as benzene-hexachloride dusts at the concentrations tested and retained their toxicity for a longer period. Five hens in a cage that were given 200 cc. poisoned grasshoppers on the day after spraying and 400 cc. on each of the next four days on each plot were not affected and had no unusual flavour when cooked.

On 18th and 19th July, 350 acres of red clover, oats and wheat stubble sown with clover, grass pasture, maize, soy beans and lucerne were sprayed with chlordane from an aeroplane. Concentrates consisting of chlordane, emulsifier and oil or xylene (50 : 20 : 30) gave almost complete control of grasshoppers when applied so as to give 1 lb. toxicant in two or five U.S. gals. diluted spray per acre, although heavy rain fell soon after application, but gave variable results when applied at 0·4 and 0·5 lb. toxicant per acre. A spray of 4 per cent. chlordane in no. 9 oil, applied at 1 lb. toxicant per acre, was slow in action and gave rather less control and also scorched soy beans, maize, and sometimes clover ; the temperature was 106°F. and there was bright sunshine while the sprays were being applied. Spraying hedgerows only seldom gave more than 50 per cent. control. The sprays had no effect on crickets in pasture or on *Epicauta solani*, Werner, and *E. vittata*, F., on potato. The first of these sprays and a 25 per cent. oil-free emulsion (or colloidal suspension) of chlordane applied by aeroplane on 31st July and 1st August, gave good results except in mature maize and clover seed fields when used at 0·8 lb. toxicant in 2 U.S. gals. water per acre, in spite of heavy rain on 2nd and 3rd August, but rain falling during spraying reduced control considerably, presumably by washing off the deposit. The last spray, used to give 1 lb. chlordane per acre, gave excellent control on maize, soy beans, *Lespedeza* and stubble fields, in spite of steady rain beginning three days after treatment, but not on old clover. Dusts applied by air did not withstand rain so well as spray deposits, all visible deposit being washed off by two days of rainfall. Benzene-hexachloride dusts (0·5 and 1 per cent. γ isomer) were more effective on clover than on maize, and chlordane dusts (2 and 5 per cent.) on maize than on clover. It appeared that sprays of chlordane acted most rapidly and most completely when applied to soy beans and young maize and were less effective in dense vegetation and on maize in silk or later stages. They were almost completely ineffective at the recommended dosages on old clover (hard and dry, without green foliage or blooms) and other crops or crop residues that were almost devoid of succulent growth. Growers using chlordane obtained better results with mist sprays than with aerosols and with water emulsions than with oil solutions.

Ludvik (G. F.) & Decker (G. C.). **Toxicity of certain Esters of Phosphorus Acids to Aphids.**—*J. econ. Ent.* **40** no. 1 pp. 97–100, 3 refs. Menasha, Wis., 1947.

Since preliminary tests showed that hexaethyl tetraphosphate, which, though toxic to warm-blooded animals, hydrolyses very rapidly in water with a subsequent rapid loss of toxicity and so eliminates the problem of toxic residues on food products, was effective against Aphids and against *Tetranychus bimaculatus*, Harvey, this and 45 other compounds of various phosphorus acids were tested in the laboratory as contact insecticides against *Myzus persicae*, Sulz., on leaves of egg-plant [*Solanum melongena*] and *M. porosus*, Sand., on rose leaves. The desired amount of compound was dissolved in a solution of 1 gm. sodium decylbenzenesulphonate (Santomerse D) in 5,000 cc. distilled water or, if it was insoluble, shaken with the solution until an emulsion or fine suspension was obtained. The sprays were applied immediately after preparation and mortality counts made 24 hours later. *M. porosus* was more resistant than *M. persicae*. Of the compounds tested, the pyrophosphates and triphosphates were extremely toxic, and tetrabutyl pyrophosphate, the hexaethyl, hexapropyl and hexabutyl tetraphosphates, the *sym.* tetrabutyl and *sym.* tetrapropyl phenyl triphosphates and the tetraethyl and tetrapropyl pyrophosphates were more so than nicotine alkaloid (95 per cent. free base). The last three were the most promising and may prove commercially useful.

The effect of the phosphorus nuclei and of substitution of various individual phosphorus nuclei on toxicity is discussed.

Wilson (H. F.), Hull (W. B.) & Srivastava (A. S.). **A Comparison of Rotenone, DDT, and Benzene Hexachloride for Pea Aphid Control.**—*J. econ. Ent.* **40** no. 1 pp. 101–103, 1 ref. Menasha, Wis., 1947.

In greenhouse tests on the control of the pea Aphid [*Macrosiphum onobrychis*, Boy.] carried out in Wisconsin during the winter of 1945–46, dusts of 1–5 per cent. DDT, alone and with 3 per cent. oil (a mixture of equal parts of SAE 10 lubricating oil and propylene laurate), gave 47–93 and 93-100 per cent. control in 24 hours, respectively, and dusts of 1–5 per cent. benzene hexachloride, alone and with 3 per cent. oil, gave 15–65 and 24–84 per cent.; 1 and 2 per cent. DDT with 0·25 per cent. rotenone and 3 per cent. oil gave 100 per cent. control, and 1 and 2 per cent. benzene hexachloride with 0·25 per cent. rotenone and 3 per cent. oil 48 and 76 per cent., respectively. All dusts that were not completely effective in 24 hours gave higher control after 72.

In one field test in 1946, oil-conditioned dusts of 3 per cent. DDT or benzene hexachloride in Pyrax, applied at about 25 lb. per acre on 13th June, resulted in 88 and 73 per cent. control on 16th June, 89 and 83 per cent. on 19th June and 82 and 38 per cent. on 23rd–26th June, respectively. In a second, in which the dusts were applied at 40 lb. per acre on 13th June and counts were made on 16th and 17th June, 2·5 and 3 per cent. DDT with 2 and 3 per cent. oil, respectively, gave 90–92 per cent. control, 1 and 2 per cent DDT with 0·5 and 0·25 per cent. rotenone, respectively, and 3 per cent. oil gave 92 per cent. control, and 5 per cent. DDT gave 88 per cent.; 2 per cent. benzene hexachloride with 0·25 per cent. rotenone and 3 per cent. oil and 5 per cent. benzene hexachloride with 2 per cent. oil gave 85–91 per cent. control, and 0·75 per cent. rotenone with 2 per cent. oil gave 89 per cent. After about ten days there was a slight reduction in control on some of the DDT plots, and a somewhat greater one on those dusted with benzene hexachloride or rotenone.

It is concluded that DDT is more effective than benzene hexachloride in the greenhouse and that oil increases the effectiveness of both compounds. There was a slight indication of synergism when rotenone was added. The field data indicate that DDT has a greater residual effect than benzene hexachloride or rotenone, that 2·5–3 per cent. DDT with an oil solvent may be as effective as 5 per cent. DDT in a dry mixed dust, and that higher concentrations of benzene hexachloride than of DDT would be required for effective control. A dust containing 0·75 per cent. rotenone, applied during a period of high temperature, was about equal to DDT during the first week after treatments were applied, although at harvest there were a few injured pods on the plot treated with it and none on any of the DDT plots. Combined low concentrations of rotenone and DDT gave good control but were not more effective than 2·5 and 3 per cent. DDT alone.

Brannon (L. W.). **Further Tests for Control of Mexican Bean Beetle and Corn Earworm on Snap Beans.**—*J. econ. Ent.* **40** no. 1 pp. 103-106, 5 refs. Menasha, Wis., 1947.

The following is based on the author's summary. In two large field-plot experiments carried out at Norfolk, Virginia, in 1946 on the autumn crop of snap beans under conditions of unusually heavy infestation by *Epilachna varivestis*, Muls., and *Heliothis armigera*, Hb., and widespread prevalence of powdery mildew (*Erysiphe polygoni*), two applications of dust mixtures containing 1 or 3 per cent. DDT, 0·5 per cent. rotenone and 50 per cent. sulphur in pyrophyllite resulted in yield increases of 57–99 bushels of marketable beans per

acre over the untreated controls, and were as effective as two applications of cryolite and sulphur (72 per cent. sodium fluoaluminate) or any insecticide yet tested for simultaneous control of the two insects and the disease [*cf. R.A.E.*, A **34** 138, 316]. Since DDT is superior to cryolite against *Empoasca fabae*, Harr., and *Thrips tabaci*, Lind., a dust of DDT, rotenone and sulphur may prove of value against all insects attacking the autumn crop of snap beans in eastern Virginia. Applications of DDT at concentrations of 3–10 per cent. caused no injury to bean foliage.

Benzene hexachloride diluted to contain 3 per cent. γ isomer gave significant control of *H. armigera*, but was less effective than the DDT dust or cryolite, and it was relatively ineffective against *Epilachna*. A commercial dust of pyrethrum and piperonyl cyclohexenone controlled both insects, but was less effective than the DDT dust or cryolite and resulted in little increase in yield, possibly owing to ineffectiveness against the mildew, and dusts containing 5 or 10 per cent. bis(paramethoxyphenyl)trichlorethane controlled *E. varivestis*, but gave variable results, apparently depending on the diluent used, against *H. armigera*. An aerosol released from a mixture containing 3 per cent. each of DDT, derris resins and lubricating oil, 10 per cent. isophorone, 31 per cent. acetone and 50 per cent. methyl chloride, which was used at the rate of 6 lb. per acre, controlled *H. armigera*, but was ineffective against *E. varivestis*, owing possibly to the low dosage of rotenone, since a 5 per cent. rotenone aerosol, applied earlier in the season at 10–15 lb. per acre had given about 60 per cent. control.

The results obtained indicated that under the usual conditions, two applications of insecticide, one about two weeks before flowering and the second when the crop is in full bloom, provide adequate protection. Insecticides applied before the pods form are unlikely to leave harmful residues on the market product. Owing to the extreme difficulty of finding appreciable numbers of eggs and small larvae of *Heliothis* and the potentially heavy damage that may result from a relatively small population, it has been found advisable in eastern Virginia to apply insecticides to the autumn crop of beans as a precaution against infestation. Since the mixture of DDT, rotenone and sulphur was also effective against *E. varivestis*, other insects attacking the beans and mildew, it should be useful for this purpose.

List (G. M.). **Some Relationships of Insects to Net Necrosis of the Potato in Colorado.**—*J. econ. Ent.* **40** no. 1 pp. 107–112, 1 fig., 1 ref. Menasha, Wis., 1947.

Net necrosis of potatoes has been common in Colorado for several years, particularly in small gardens and plantings, and caused heavy losses in commercial fields in 1944. The author describes the symptoms in the tubers and also those in the vines, which are difficult to distinguish from the symptoms of psyllid yellows, induced by *Paratrioza cockerelli*, Šulc. In greenhouse tests in the winter of 1943–44, potato plants that were receiving different programmes of sprays and dusts, were constantly exposed to Psyllids moving from heavily infested potato and tomato plants and bore infestations varying from 0·1 to 1,176·6 nymphs per 15 leaflets (on plants receiving a 3 per cent. DDT dust and no treatment, respectively) showed varying degrees of Psyllid yellows but no necrosis, and similar results were obtained in 1944–45. In field tests in 1944 on the control of *P. cockerelli* and *Epitrix tuberis*, Gentner, it was observed that sprays of 1 lb. DDT per 100 U.S. gals. or dusts of 3 per cent. DDT in an inert carrier or 1 per cent. DDT in sulphur and inert carrier (2 : 1) caused significant reductions in the populations of leafhoppers, largely *Macrosteles divisus*, Uhl., and that the numbers of leafhoppers were closely correlated, except in the

control plot, with the numbers of badly discoloured plants and the quantity of necrotic tubers.

In view of this and of the finding of Leach & Bishop that the virus of aster yellows (*Chlorogenus callistephi* of Holmes), which is transmitted by *M. divisus*, causes discoloration of the vines and is accompanied by net necrosis of the tubers in potatoes [*cf. R.A.E.*, A **33** 173, etc.], field tests were carried out in 1945 in which the development of net necrosis of potatoes and of aster yellows on asters was compared on plots of which some were enclosed in cloth fences 3 ft. high to exclude *M. divisus* but not the Psyllid and were artificially infested with Psyllids, as necessary, to keep up the population, and others were dusted every seven days with sulphur to control the Psyllid or with a preparation containing 90 per cent. sulphur, 5 per cent. DDT and 5 per cent. inert material to control the Psyllid and possibly the leafhopper or were left untreated. There was no significant difference in the numbers of tubers or the numbers of aster blossoms produced with the different treatments, indicating that the psyllid yellows and aster yellows that appeared must have developed after the plants were well established. The Psyllid populations were high and equal and the tuber yields low and equal for both fenced and unfenced untreated plants, but only three small tubers from the fenced plants showed necrosis, as compared with more than 30 per cent. of the total from the unfenced ones. Diseased aster flowers were also far more numerous on the unfenced plots. The dusted plots all had low Psyllid populations, with no significant difference betwen them, though 5 per cent. DDT in sulphur gave better control than sulphur alone, and significantly higher yields than the undusted ones. There was no significant difference in the numbers of necrotic tubers in these plots, though the numbers were significantly lower than on the controls, indicating that sulphur, with or without DDT, had some effect on the cause of the disease. There was no significant difference in the number of diseased aster blossoms on the dusted plots, though the combination of sulphur and DDT appeared to give rather more protection than sulphur alone. Analysis of the results showed that the Psyllid had a highly significant effect on the yield of potatoes but no effect on the occurrence of aster yellows in the aster blossoms or of net necrosis of the tubers, whereas the leafhopper had a highly significant effect on the number of diseased aster blossoms and a significant effect on the number of necrotic tubers. Observations in 1946 supported the conclusion that net necrosis in potatoes is a symptom of aster yellows and not of psyllid yellows.

GAINES (J. C.), OWEN jr. (W. L.) & WIPPRECHT (R.). **Effect of Dusting Schedules on the Yield of Cotton.**—*J. econ. Ent.* **40** no. 1 pp. 113–115, 3 refs. Menasha, Wis., 1947.

The usual recommendations for the control of insects attacking cotton in the United States involve dusting with calcium arsenate, beginning when 10 per cent. of the squares are infested by the weevil [*Anthonomus grandis*, Boh.] or even with the pre-square stage if large numbers of overwintering weevils are present, but although these practices help to set the early bolls, they favour Aphids [*Aphis gossypii*, Glov.] and the bollworm [*Heliothis armigera*, Hb.] by destroying their natural enemies and have not proved economical in some areas, and records in Texas over a number of years have indicated that cotton protected only during the last three weeks in July and August will yield as much as the soil is capable of producing [*cf.* also *R.A.E.*, A **32** 275]. Experiments were carried out in two localities in Texas in 1946 to compare the effectiveness of early dusting to control thrips, followed by a complete programme for the control of the weevil and the bollworm [*Heliothis armigera*, Hb.], the standard programme against weevil and bollworm, and late dusting. At College Station, where the thrips population was low early in the season and

caused little or no injury, though nearly 45 per cent. of the plants were malformed and had injured buds, two early applications of 5 per cent. DDT in sulphur and a pre-square application of calcium arsenate did not increase the yield given by the normal programme, whereas six late applications of sulphur, calcium arsenate and 50 per cent. DDT (20 : 70 : 10) between 12th July and 12th August reduced the average infestation by the weevil from about 50 to about 28 per cent., gave adequate bollworm control and resulted in almost as high a yield of cotton as full programmes of 11–13 applications of calcium arsenate (1,297 and 1,358 lb. seed cotton per acre, as compared with 823 lb. in the controls). This dust did not give better control of the bollworm than calcium arsenate alone. At Terrell, where the thrips population was high early in the season, but caused only 13–16 per cent. malformed plants, the two early applications of 5 per cent. DDT in sulphur tended to reduce the numbers of thrips and malformed plants, but did not increase the yield given by the standard programme. The average weevil infestation was about 69 per cent. from 15th June to 16th July, before the beginning of the late schedule of three applications of calcium arsenate dust. All schedules failed to produce profitable increases in yields. A large increase in bolls was observed in the treated plots early in July, but during the latter part of the month a large proportion of those that had been set as a result of weevil control were shed, and the final yield was very little above that of the controls. Apparently as much fruit as the soil was capable of producing under the existing weather conditions was set without any protection from insects.

It is concluded that it may be more profitable to dust cotton during the last three weeks of July and August, when the weevil and bollworm are most injurious in these areas, than to try to protect it during the entire season.

Wolcott (G. N.). **The Permanence of Termite Repellents.**—*J. econ. Ent.* **40** no. 1 pp. 124–129, 3 refs. Menasha, Wis., 1947.

Since few of the trees grown in temperate zones have wood that is resistant to attack by the West Indian dry-wood termite, *Kalotermes* (*Cryptotermes*) *brevis*, Wlk. [*cf. R.A.E.*, A **35** 375], artificial protection of the temperate-zone woods commonly used in furniture or buildings is necessary if they are to be useful in the West Indies. Many chemicals are repellent to this termite, and each of these must be evaluated according to its specific characteristics, of which possibly the most important is permanence.

In tests in Porto Rico with wood immersed in the solutions for ten minutes, copper ortho- and pyro-phosphates were initially much more repellent than copper sulphate [*cf.* **34** 173], but within a year *K. brevis* ate wood treated with solutions of 0·2 per cent. copper as the first two compounds, whereas wood treated with 0·15 per cent. copper as the sulphate was uneaten after four years. Wood treated with solutions containing 0·02 per cent. copper or zinc as the fluoride remained uneaten after 30 and 22 months, respectively. The fluosilicates and fluoborates of zinc and copper were as repellent as the fluorides at first, but were less lasting, though 0·05 per cent. zinc as the fluosilicate was still protecting the wood after exposure for 14 months. The fluorides of cadmium, antimony, mercury and lead were initially more repellent than any other compounds of these metals, but lost their efficiency in a few months. Chlorinated terpenes, chlorinated fractions of cashew-nut shell oil and the crude oil showed repellence that was probably not permanent, but chlorination of the resinous gum of cypress or of oil of cedar gave greater promise, and chlorinated crude cardol remained effective after a year at a concentration of 5 per cent. and chlorinated crude anacardic acid after even longer. The commercially available naphthenates of the repellent metals were not particularly effective, 12 per cent. solutions being required to protect wood samples

for two years, whereas the pentachlorphenates of sodium, lead, copper and zinc proved repellent for as long as they were tested (18 months or more) at a concentration of 0·2 per cent. [*cf.* **34** 172, etc.]. Ferric dimethyldithiocarbamate (Fermate) was somewhat toxic to termites at first, but failed to protect the wood from attack after about six months at concentrations of less than 0·5 per cent. Comparable concentrations of the copper and zinc dimethyldithiocarbamates were very toxic at first but much less so after a year, and concentrations of 0·1 per cent. did not prevent the wood from being eaten after 16 months. The chloride and the stearate of pyridyl-mercury proved equally repellent and rather more so than diphenyl mercury and phenylmercuric chloride, but all mercury compounds are probably too expensive for commercial use. Pentabromophenol protected wood for only two weeks at 0·5 per cent. but still protected it after two years at 1 per cent., and 2 per cent. DDT continued to give protection after 33 months [*cf.* **34** 172].

The wood of *Bursera simaruba* [*cf.* **34** 172, etc.] was replaced in some of the later tests by that of *Poinciana* (*Delonix*) *regia*, which is even more susceptible to attack by *K. brevis* and showed much less effective protection by alizarin [*cf.* **35** 375], 0·05 and 1 per cent. repelling the termites for only 8 and 95 days as compared with 107 and 147, respectively.

COOLEY (C. E.). **International Air Commerce and Plant Quarantine.**—*J. econ. Ent.* **40** no. 1 pp. 129–132, 6 refs. Menasha, Wis., 1947.

The development of inter-continental air transport has increased the risk of carrying injurious insects by aircraft, and although the danger of transporting insect vectors of human diseases is probably greater than that of transporting agricultural insects, the former are easily killed in the aircraft by thorough treatment with an aerosol, whereas the immature stages of fruit-flies, thrips and some Lepidoptera and the adults of most beetles and Coccids are more resistant. It seems likely that a pest has a greater chance of survival if it arrives with its food-plant, and instances are given of insects intercepted in the United States on prohibited plant material carried by aeroplanes in 1944–45.

The author considers that effective inspection of all arriving aircraft by adequately trained staff and thorough insecticidal treatment of all enclosed portions of the machine, preferably just after take-off and again just before landing, are necessary, and that there is urgent need for further research on the development of more effective insecticides and better methods of application. He emphasises the desirability of developing an efficient international system of inspection and also records suggestions that all vegetation in the vicinity of international airports should be continually treated with DDT and other insecticides to prevent the establishment of any pests that may escape from arriving aeroplanes and that various types of insect traps should be maintained in their neighbourhood.

He concludes that in view of the speed with which insect pests and plant diseases can be transported by aircraft, the present inspection and safeguarding of agricultural imports at the port of entry should be supplemented by periodical pest surveys in foreign countries from which plants or unprocessed plant products are imported and by continual surveys for introduced pests in the vicinity of ports of entry.

O'KANE (W. C.). **Results with Benzene Hexachloride.**—*J. econ. Ent.* **40** no. 1 pp. 133–134. Menasha, Wis., 1947.

The results are given of preliminary tests in New Hampshire with benzene hexachloride, used as a dust in pyrophyllite (Pyrax ABB), or as a wettable

powder in suspension. One application of a dust containing 0·5 per cent. γ isomer gave complete control of the Colorado potato beetle [*Leptinotarsa decemlineata*, Say], the potato flea-beetle [*Epitrix cucumeris*, Harr.], larvae of the three-lined potato beetle [*Lema trilineata*, Ol.], the cabbage Aphid [*Brevicoryne brassicae*, L.], the cabbage looper [*Trichoplusia ni*, Hb.], the asparagus beetle [*Crioceris asparagi*, L.], the garden fleahopper [*Halticus bracteatus*, Say] on tomato, the corn earworm [*Heliothis armigera*, Hb.] and the rice weevil [*Calandra oryzae*, L.] on maize ears, the greenhouse leaf tier [*Phlyctaenia rubigalis*, Gn.], the gladiolus thrips [*Taeniothrips simplex*, Morison], the elm leaf beetle [*Galerucella luteola*, Müll.], larvae of Leconte's sawfly [*Neodiprion lecontei*, Fitch], nymphs and adults of *Corythucha pergandei*, Heid., the European elm scale [*Gossyparia spuria*, Mod.], *Melanoplus* spp., and the black cherry Aphid [*Myzus cerasi*, F.], and good control of the spiny elm caterpillar [*Nymphalis antiopa*, L.], larvae of the cottonwood leaf beetle [*Melasoma lineatopunctata*, Forst.] on willow, and several species of ants living in the soil when made on the surface of the soil. One application of 0·5 per cent. dust at 50–60 lb. per acre gave almost complete control of the onion thrips [*Thrips tabaci*, Lind.] on onion and was best in the presence of dew, and one application at 40 lb. per acre, followed by one at 30 lb. per acre ten days later, gave almost complete control of the same thrips on tomato. The striped flea-beetle [*Phyllotreta vittata*, F.] was readily controlled with the 0·5 per cent. dust, the striped cucumber beetle [*Diabrotica melanocephala*, F.] with one or more applications of 0·5 or 0·25 per cent. dusts, and the spinach flea-beetle [*Disonycha xanthomelaena*, Dalm.] with 0·25 per cent. dust. A single application of 0·5 per cent. dust gave satisfactory control of the fall webworm [*Hyphantria cunea*, Dru.] provided that the dust came in contact with the larvae, about 80 per cent. control of the spiraea Aphid [*Aphis spiraecola*, Patch], and nearly complete kill of the nymphs and considerable kill of the adults of the squash bug [*Anasa tristis*, Deg.]; two or more applications gave 70–100 per cent. kill of the imported cabbage worm [*Pieris rapae*, L.], three gave 90 per cent. control of the apple Aphid [*Aphis pomi*, Deg.], and one application of 4 per cent. dust at 50 lb. per acre gave complete control of the hairy chinch bug [*Blissus hirtus*, Montd.]. One or more applications of the 0·5 per cent. dust apparently killed adults of the greenhouse whitefly [*Trialeurodes vaporariorum*, Westw.], though the nymphs appeared to be resistant, but gave unsatisfactory results against larvae of the Mexican bean beetle [*Epilachna varivestis*, Muls.], and 1–5 applications were unsatisfactory against the potato leafhopper [*Empoasca fabae*, Harr.]. Benzene hexachloride showed marked repellency to the Japanese beetle [*Popillia japonica*, Newm.], and adults caged on dusted plants died. Predacious Coccinellids were apparently resistant, since many survived field applications of the dusts and no dead adults were found.

Five applications of the 0·5 per cent. dust and of a spray containing 0·075 lb. γ isomer per 100 U.S. gals. reduced the numbers of *Myzus persicae*, Sulz., *Macrosiphum solanifolii*, Ashm., and *Aphis rhamni*, Boy. (*abbreviata*, Patch) on potato to 25 and 158 per 50 lower leaves, respectively, as compared with 1,497 on plants sprayed with calcium arsenate. Wettable-powder sprays containing 0·05 and 0·075 lb. γ isomer per 100 U.S. gals. killed 70–100 per cent. of *Epitrix cucumeris* and of larvae and adults of *Leptinotarsa*.

Crude benzene hexachloride may cause an objectional flavour in some food products. Potatoes developed an unpleasant flavour in some tests, but not in others, and peas were sometimes made bitter. String beans were affected unless the applications were widely spaced and completed some time before picking, but tomatos and bell peppers [*Capsicum*] had no objectionable flavour after two applications ten days apart, though they were sometimes affected by a larger number of applications. Sweet maize developed a slight undesirable flavour after several dustings, but cucumbers showed none after five applications and strawberries none after nine weekly applications. Cabbage, onions,

and carrots had no unpleasant taste, and applications early in the season produced none in squash and melon.

SNAPP (O. I.). **Experiments in 1946 on the Control of Bugs that cause deformed Peaches.**—*J. econ. Ent.* **40** no. 1 pp. 135–136, 1 fig., 1 ref. Menasha, Wis., 1947.

In 1946, tests on the control of the bugs that deform peaches in South Carolina were directed chiefly to determining the relative value of pre-blossom, petal-fall and sepal-fall applications of DDT and combinations of them [*cf. R.A.E.*, A **35** 176–177]. Sabadilla and benzene hexachloride were also tested.

Sprays of 1 lb. DDT (micronised with 1 lb. pyrophyllite) per 100 U.S. gals., with 1 U.S. pint of a solution of 1 lb. fish glue per U.S. gal., 0·33 lb. of a wettable powder containing 31·6 per cent. benzene hexachloride reported to contain 12 per cent. γ isomer per 100 U.S. gals., and 1 lb. of a wettable powder containing about 50 per cent. sabadilla seed per 100 U.S. gals. were applied at the rate of 1–2 U.S. gals. per tree. One application of DDT at the pre-blossom, full-bloom, petal-fall or sepal-fall stage reduced the percentage of damaged peaches just before harvest from 40 to 23·4, 14, 9·6 and 16·2, respectively, and two applications, at petal-fall and sepal-fall, and three, at pre-bloom, petal-fall and sepal-fall, to 6·2 and 7·2. Single sprays of sabadilla and benzene hexachloride at full bloom reduced it to 29·6 and 18·4, respectively. There was no significant difference between the results for three and two sprays of DDT and one spray at petal-fall, but a single pre-blossom application appeared less effective than one at full-bloom or petal-fall. The results from the single application at the sepal-fall stage suggested that some injury from sucking bugs occurs after this time, and jarring records indicate that Pentatomids are most likely to have caused it. An application at petal-fall would be preferable to one at full-bloom, to avoid harming insect pollinators, although these are not important on peach. Benzene hexachloride showed promise and was not significantly less effective than DDT ; it did not affect the flavour of the fruit at harvest when applied at full-bloom. Sabadilla appeared comparatively ineffective.

No bugs were obtained from untreated trees jarred on 7th March, when about 5 per cent. of the blossoms were open, or on 15th March, at full bloom, owing to unfavourable weather, but *Lygus oblineatus*, Say, was jarred from every tree on 21st March, when about 85 per cent. of the petals had fallen, the average number per tree being more than five. On 4th April, after practically all the sepals were off, the average number of *L. oblineatus* had decreased to 0·25 per tree, and a few Pentatomids, averaging 0·42 per tree, were also collected. These belonged to the species *Thyanta custator*, F., *Euschistus servus*, Say, and *Brochymena quadripustulata*, F. Neither Pentatomids nor *Lygus* were taken from trees jarred on 16th May, when the stone of the fruit was almost hardened.

CARPENTER (S. J.). **Control of Stored Food Insects with Benzene Hexachloride.** —*J. econ. Ent.* **40** no. 1 pp. 136–137. Menasha, Wis., 1947.

In laboratory experiments to determine whether benzene hexachloride could be used against insects attacking stored food products, larvae and adults of *Tribolium confusum*, Duv., *Attagenus piceus*, Ol., and *Dermestes maculatus*, Deg. (*vulpinus*, F.) and adults of *T. castaneum*, Hbst., *T. madens*, Charp., *Gnathocerus cornutus*, F., *Oryzaephilus surinamensis*, L., *Tenebroides mauritanicus*, L., and *Calandra* (*Sitophilus*) *oryzae*, L., were put in wooden boxes that had been lightly sprayed with a mixture of benzene hexachloride and some pyrethrum extract about an hour before. All the insects showed symptoms of poisoning within 10–15 minutes and were dead in 4·5–24 hours. The only

significant difference in susceptibility noted was that *C. oryzae* survived for considerably longer than the other insects. On 25th November, 30 adults of *Tribolium confusum* were placed in a box that had been treated with benzene hexachloride on 1st October, and 14 were dead and the remainder moribund after 24 hours. Adults of *O. surinamensis* and larvae and adults of *T. confusum* that were exposed to a smoke of technical benzene hexachloride (about 12 per cent. γ isomer), used at the rate of 50 gm. per 1,000 cu. ft. space, were all alive and normal after 24 hours. No odour or taste of benzene hexachloride was detected in bread made from flour exposed to the smoke or spray, and it is considered unlikely that the compound will be objectionable when used as a spray in localised infested areas in bakeries and other establishments in which food is handled.

Hill (R. E.) & Hixson (E.). **Hexachlorocyclohexane Dusts and Fogs to control Grasshoppers.**—*J. econ. Ent.* **40** no. 1 pp. 137–138, 1 fig. Menasha, Wis., 1947.

Dusts and a fog of benzene hexachloride were tested against grasshoppers in Nebraska in the summer of 1946 ; collections made in mid-August showed that 98 per cent. of the grasshoppers present consisted of *Melanoplus differentialis*, Thos., *M. femur-rubrum*, Deg., *M. bivittatus*, Say, and *M. mexicanus mexicanus*, Sauss. Benzene hexachloride dust diluted with pyrophyllite to contain 0·58 per cent. γ isomer, applied to a stretch of lucerne and weeds with a hand-operated dust gun at about 45 lb. per acre on the evening of 16th July, gave an estimated kill of 95 per cent. of the nymphs ; no adults were present. In a small test, dusts containing 0·58 and 5 per cent. γ isomer gave 70 and 95 per cent. mortality, respectively, and many grasshoppers that subsequently moved into the area that had received the stronger dust were found dying 2 and 3 days after application. Dusts containing 1, 2 and 5 per cent. γ isomer, applied to two-acre blocks of lucerne with a power duster at about 25 lb. per acre early in the morning of 21st August, reduced the numbers of grasshoppers per 100 sweeps of a net from 138, 128 and 266 before treatment, to 26, 2 and 21 after 15 hours and 3, 1 and 5 after 24 hours. The results obtained from applying dusts containing 1, 1·5 and 5 per cent. γ benzene hexachloride from an aeroplane, under poor dusting conditions, indicated that this method would be satisfactory under favourable conditions.

The fog was produced from a mixture of 5 lb. of a wettable product containing 5 per cent. γ benzene hexachloride in 10 U.S. gals. water and was applied to strips of lucerne 5 ft. wide and totalling ¾ mile in length on the evening of 21st July from a machine moving at 2 miles per hour ; 9 U.S. gals. were used in all, and about 85 per cent. control resulted in 15 hours.

It is concluded that benzene hexachloride gives effective control of grasshoppers when applied as a dust or fog and would be superior to baits under many conditions. All four species and all the developmental stages tested were equally susceptible. In the insectary, undusted grasshoppers crawling over dusted foliage and feeding on it were affected in eight minutes, and in one field observation, dusts containing 1·15 and 5 per cent. γ isomer were still effective six days after application. Dusts containing 1 or 2 per cent. γ benzene hexachloride caused no visible injury to lucerne, maize or potato when applied at 25–30 lb. per acre, but a 5 per cent. dust and heavy applications of a 2 per cent. dust caused chlorosis of potato foliage, so that further observations on the effects of the compound on plants are needed.

List (G. M.) & Hoerner (J. L.). **Dusts and Sprays for Grasshopper Control.**—*J. econ. Ent.* **40** no. 1 p. 138. Menasha, Wis., 1947.

In tests of dusts and sprays for the control of adult grasshoppers, mainly the wo-striped, red-legged and differential grasshoppers [*Melanoplus bivittatus*,

Say, *M. femur-rubrum*, Deg., and *M. differentialis*, Thos.], in Colorado in September 1946 on ground with an average infestation of 6 per sq. yd., in which the results were estimated after eight days, dusts of 5 per cent. chlordane [*cf. R.A.E.*, A **36** 225–226], applied at 1 lb. active ingredient per acre, gave 98 per cent. control, 10 per cent. benzene hexachloride (10 per cent. γ isomer) at 2 and 3 lb. γ isomer per acre and 5 per cent. at 2·5 lb. per acre gave 90, 96 and 98 per cent., and 25 per cent. DDT at 5 lb. DDT per acre, 20 per cent. Toxaphene [*cf.* **36** 224] at 3 lb. toxicant per acre, and 10 per cent. di(methoxyphenyl) trichlorethane at 1·5 lb. toxicant per acre gave 50, 95 and 95 per cent., respectively. Sprays of 1 lb. chlordane or 1,1,1-trichlor-2,2 bis(parabromophenyl)ethane (Colorado 9), dissolved in 1 U.S. quart xylene with 50 cc. of an emulsifier, and of 2 lb. Toxaphene per acre, all in 50 U.S. gals. water, gave 98, 40 and 95 per cent. control, respectively, and dusts of 5 per cent. chlordane and benzene hexachloride applied from an aeroplane at 1 lb. active ingredient per acre gave 80 and 40 per cent., respectively. The Toxaphene, benzene-hexachloride and chlordane dusts were still effective six and seven days after application. Pyrophyllite was the diluent in all the dusts.

Guilhon (J.). **Sensibilité des abeilles aux insecticides synthétiques.**—*C. R. Acad. Agric. Fr.* **32** no. 7 pp. 246–249. Paris, 1946.

In the investigations described, honey bees were taken as they left the hive in the morning, introduced singly into tubes containing 5 mg. of the material under test, where they were left for one minute, and then transferred to a wire-gauze cage. It was observed that about one-fifth of the amount of material in the tubes adhered to the bees. The behaviour of the treated individuals is described in detail, and the results are given in tables showing the periods within which paralysis and death occurred. At 25°C. [77°F.], the numbers of minutes required for death were 176 for technical benzene hexachloride, 168 for 3 per cent. of the same in talc, 250, 230 and 153 for the α, β and γ isomers of benzene hexachloride, 230, 190 and 148 for 3 per cent. of the same in sulphur, 220 and 204 for pure and technical DDT, and 155 and 173 for two samples of technical polychlorcyclane sulphide, respectively. When the temperature was reduced to 18°C. [64·4°F.], the figures rose to 270, 267 and 258 for α, β and γ benzene hexachloride, 378, 381, and 338 for the same in sulphur and 266 for pure DDT, and when it was raised to 32–35°C. [89·6–95°F.], they were 153 for 3 per cent. benzene hexachloride in talc, and 210, 149 and 160 for the three isomers in sulphur. DDT in the form of Gesarol required 258, 361, and 117 minutes at the three temperatures, respectively. Gammexane, a British preparation of benzene hexachloride tested at 25 and 32–35°C., proved very nearly as toxic as 3 per cent. of the technical product in talc. It is pointed out in view of these results that if bees come into contact with these insecticides on plants, they will not only die themselves, but, if they return to the hive, may affect other bees. Pollen contaminated with these insecticides and brought to the hive might endanger the brood, the young bees and the queen.

Feytaud (J.). **Action du sulfure de polychlorocyclane sur le criquet migrateur (*Locusta migratoria* L.).**—*C. R. Acad. Agric. Fr.* **32** no. 7 pp. 266–270. Paris, 1946.

In view of the widespread and abundant oviposition by *Locusta migratoria*, F., phase *gregaria*, in the Gironde [*cf. R.A.E.*, A **35** 377] in the autumn of 1945, the results are given of tests of insecticides made against the adults during the summer of that year. In small-scale field tests in July, in which 10 per cent. derris or 4 per cent. benzene hexachloride, polychlorcyclane sulphide [**35** 313] or DDT in talc were applied during the heat of the day, polychlorcyclane sulphide

was the most effective of the three synthetic compounds, but all were less rapid in action than the derris, although this had been in store for six years. In laboratory tests during August-September on the effect of polychlorcylcane sulphide on 12 adults of phase *transiens congregans*, the dust was placed on the spiracles, tympanum, mouth-parts, the median line of the ventral surface or back, the anal region or the point of attachment of the wings; the locusts all died, but the symptoms were in general the most violent and the locusts were killed the most quickly when the dust was applied on the first three sites, the periods after which death occurred being 11, 6½–34 and 18–34 hours, respectively; a locust on which the dust was applied at the point of attachment of the wings survived for nearly 70 hours. Polychlorcyclane sulphide applied to the mouth is not necessarily ingested, but may pass through the chitin and affect the nerves of the mouth-parts; similarly, when applied to the spiracles, it may produce effects other than respiratory poisoning. The observed symptoms, which comprised convulsions, loss of balance and paralysis and developed after a period during which the behaviour of the locusts was normal, indicate that it is a nerve poison.

Besson [J.] & Scala [A.]. **Observations sur les méfaits de la tordeuse orientale du pêcher (*Laspeyresia molesta* Busck) dans le sud-ouest de la France en 1945.**—*C. R. Acad. Agric. Fr.* **32** no. 10 pp. 422–424, 2 refs. Paris, 1946.

Cydia (*Laspeyresia*) *molesta*, Busck, has been present in south-western France for several years. Its exact distribution there is not yet known, but it does not appear to occur so far south as the Pyrenees; the observations recorded in this paper were made in the valley of the Garonne, between Toulouse and Bordeaux. The moth became important in 1945 as a result of an exceptionally early spring and a hot autumn. The adults appeared in April and four complete but very extended and overlapping generations developed on peach. All four infested the shoots, while the third and fourth also developed in late-ripening peaches, and the fourth injured shield-buds grafted in autumn, causing them to dry up, and also damaged pear. Peach fruits are not normally attacked until fairly late in the season, but peaches that had fallen from trees of two varieties near Toulouse were found to be infested on 19th May, and infestation on peaches and nectarines at Bordeaux was as high as 15 and 30 per cent. in the shoots and unripe fruits, respectively, on 17th June. All the varieties of peach grown at an experimental station near Bordeaux were attacked; by the middle of October, 95 per cent. of the crop was infested and some fruits contained 9–10 larvae each. In September, after the harvest, the larvae penetrated the bark of lignified branches of peach, apricot and cherry, through injuries caused during budding or by hail. Infestation of newly budded plants ranged from 3 to 40 per cent. when they were budded close to the ground and reached 80 per cent. on those budded on tall stock. Infested trees produced a strong exudation of gum, which sometimes killed the larva and generally killed the shield-bud. Larvae sometimes entered undamaged stems of apricot nursery stock through the enlargement at the base of the branches, and at Montauban, larvae in the last instar were found in the spur-branches of pear. Pears in the valley of the Garonne sustained important damage, and near Toulouse, 50 per cent. of the harvested fruit was infested; attack occurred chiefly between 15th August and 23rd September, presumably as a result of oviposition by third-generation adults, and fruits that received an arsenical spray on 21st August were not damaged. The twigs of hybrids of peach and almond were also attacked, and infestation of the tips of peaches and plums in nurseries at Marmande reached 90 and 70 per cent., respectively, in October; cherry shoots were damaged to some extent at one place, and larvae were found in apple shoots near Pau in May. Near Bordeaux, ornamental shrubs such as

Prunus (*Cerasus*) *laurocerasus* were attacked. Infested terminal shoots showed a characteristic wilting in October accompanied by exudation of gum, splitting of the stalks and yellowing of the leaves. Similar observations were made in the laboratory, where some larvae consumed only the epidermis of the leaf and sheltered in the roll produced as a result of the destruction of the tissues of one side only. Under experimental conditions, last-instar larvae attacked and webbed together grapes that were almost ripe ; some larvae occurred in the pedicels, but none in the young shoots.

Otten (E.). **Beiträge zur Kenntnis der** *Diprion*-**Parasiten. 2. Chalcididen als** *Diprion*-**Parasiten. (Fortsetzung und Schluss.)** [Contributions to the Knowledge of the Parasites of *Diprion*. 2. Chalcidoids as Parasites of *Diprion*. (Continuation and End.)]—*Arb. physiol. angew. Ent. Berl.* **9** no. 3 pp. 158–169, 2 pls., 56 refs. Berlin, 1942.

In addition to a few parasites of the cocoon stages of *Diprion pini*, L., in Germany of which the status is doubtful, the species dealt with in this second part of a paper of which the first has already been noticed [*R.A.E.*, A **32** 71] comprise *Achrysocharella ruforum*, Krausse, *Tetracampe diprioni*, Ferrière, *Entedon ovulorum*, Ratz., *Closterocerus* sp. and *Tetrastichus oophagus*, sp. n., of which the female is described. All were reared from the eggs of *D. pini* in Germany, and notes are given on the alternative hosts of some of them. It is stated that of the parasites recorded from the cocoons in the first part [*loc. cit.*], *Mormoniella vitripennis*, Wlk., and *Habrocytus eucerus*, Ratz., were hyperparasitic in all cases, and *Amblymerus subfumatus*, Ratz., *Dahlbominus* (*Microplectron*) *fuscipennis*, Zett., and *Monodontomerus obsoletus*, F., in some. Keys to all the species dealt with are appended.

de Brouwer (W. M. T. J.). **Een aantasting door een mijt, vermoedelijk** *Phyllocoptes fockeui* **Nal., bij perziken en pruimen onder glas.** [Infestation of Peaches and Plums under Glass by a Mite, probably *Vasates fockeui*, Nal. & Trt.]—*Tijdschr. PlZiekt.* **52** pt. 5–6 pp. 163–165, 2 pls., 2 refs. Wageningen, 1946. (With a Summary in French.)

In the summer of 1946, the leaves of young peach and plum trees in greenhouses in various districts in western Holland were infested by a mite that was identified as *Vasates* (*Phyllocoptes*) *fockeui*, Nal. & Trt. Most of the trees had been planted during the previous winter, and it was thought that the mites had been introduced into the greenhouses with young nursery stock at the same time. The injury to plum was typical [*cf. R.A.E.*, A **29** 305] ; that on peach, which is less well known, consisted of dwarfing and discoloration and curling of the foliage. The mites occurred on both surfaces of the leaves and were very active. Dusting with sulphur and spraying with 0·1 per cent. nicotine gave good results in the laboratory and in greenhouses ; in limited laboratory tests, dusts of DDT (Gesarol) and benzene hexachloride were less effective. Thorough treatment of nursery stock is considered advisable to prevent the spread of infestation.

Brown (N. R.). **Studies on Parasites of the Spruce Budworm,** *Archips fumiferana* **(Clem.). I. Life History of** *Apanteles fumiferanae* **Viereck (Hymenoptera, Braconidae).**—*Canad. Ent.* **78** no. 6 pp. 121–129, 2 pls., 6 refs. Guelph, Ont., 1946.

About 60 species of parasites have been identified as attacking *Harmologa* (*Archips*) *fumiferana*, Clem., in eastern Canada, where this Tortricid is at present the most injurious forest pest [*cf. R.A.E.*, A **33** 143]. One of the more

important is *Apanteles fumiferanae*, Vier., which was recorded from larvae on white spruce [*Picea glauca*] and balsam fir [*Abies balsamea*] in Quebec and Ontario during 1941–44. All stages of this Braconid are described, characters distinguishing the adults from those of closely related species are indicated, and a brief account is given of its life-history, together with that of its host [*cf.* **33** 313]. Near Chalk River, Ontario, the adult parasites emerged when the budworms were hatching, in July, and laid their eggs in the newly-hatched larvae. The parasites overwintered, at least in some cases as eggs, in second-instar larvae. Development was continued in the spring, and the full-fed larvae emerged from fourth- or fifth-instar larvae of *H. fumiferana* and pupated in cocoons attached to the needles or to budworm webbing ; the adults emerged 5–16 days later. The average periods spent in the cocoon in different districts of Ontario were 8–12 days for males and 11·5–12·5 days for females.

Annual Report of the Forest Insect Survey . . . 1945.—67 pp., 16 maps. Ottawa, Dep. Agric. Canada, 1946.

These reports on the status of the pests of forest and shade trees in Canada in 1945, which include notes on the natural enemies of some of them, are arranged on the same lines as those for previous years [*cf. R.A.E.*, A **33** 354 ; **34** 377]. W. A. Reeks, C. C. Smith and R. S. Forbes deal with the Maritime Provinces and Newfoundland (pp. 7–19, 4 maps), L. Daviault & R. Lambert with Quebec (pp. 20–26, 2 maps), E. B. Watson & M. MacKay with southern Ontario (pp. 27–34, 1 map), G. A. Bradley with northern Ontario (pp. 35–42, 2 maps), R. R. Lejeune with the forested area of the Prairie Provinces (pp. 43–52, 3 maps), L. O. T. Peterson with the agricultural area of the Prairie Provinces (pp. 53–60, 2 maps), and H. B. Leech with British Columbia and the Rocky Mountain National Parks (pp. 61–67, 2 maps).

List of Intercepted Plant Pests, 1945.—*S.R.A., B.E.P.Q.* [1945] 47 pp. [Washington, D.C.] U.S. Dep. Agric., 1946.

This list of pests intercepted between 1st July 1944 and 30th June 1945 with plants or plant products entering United States Territory (including Hawaii and Porto Rico) resembles the previous one [*R.A.E.*, A **34** 183] in the selection and arrangement of the data.

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Scaramuzza (L. C.). **Los insectos y otros animales que atacan a la caña de azúcar en Cuba.** [Insects and other Animals that attack Sugar-cane in Cuba.]—[*In*] Agete y Piñero (F.). La caña de azúcar en Cuba 2 pp. 527–563, 1 col. pl., 18 figs., 5¾ pp. refs. Havana, Estac. exp. Caña de Azúcar, 1946.

Ashby (D. G.) & Wright (D. W.). **The immature Stages of the Carrot Fly** [*Psila rosae*, F., morphology and anatomy].—*Trans. R. ent. Soc. Lond.* **97** pt. 14 pp. 355–379, 21 figs., 14 refs. London, 1946.

Roark (R. C.). **Review of United States Patents relating to Pest Control** [January 1947–April 1948] **20** nos. 1–12 : 5, 8, 6, 7, 4, 5, 7, 5, 3, 6, 5, 6 pp. multigraph. ; **21** nos. 1–4 : 4, 5, 5, 5 pp. multigraph. [Washington, D.C.] U.S. Dep. Agric. Bur. Ent., 1947–48.

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